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Vol. I.

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Published by Mess.rs Sherwood & Co. Jan. 22 1807.

THE

Contemplative Philosopher:

OR

SHORT ESSAYS

ON THE

VARIOUS OBJECTS OF NATURE

NOTICED THROUGHOUT THE YEAR;

WITH

POETICAL ILLUSTRATIONS,

AND

MORAL REFLECTIONS ON EACH SUBJECT.

BY RICHARD LOBB.

Fourth Edition, Corrected and Improved.

IN TWO VOLUMES.
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PREFACE.

THE Essays, under the title of the *Contemplative Philosopher,* appeared originally in a well known periodical Miscellany; and were then so highly approved, and so eagerly inquired after, that it was thought expedient to publish them in a *collected form.* The favourable reception of the Work in that shape, evinced by the rapid and extensive sale of two large impressions, and by its extreme rarity for a long time past, added to the repeated demands for copies, have induced the Proprietors to prepare a *new edition;* and, that it may be found still more deserving of public patronage, they have subjected the several papers to the careful revision of a gentleman of considerable reputation as a writer on philosophical topics.

The *Editor* has not considered it requisite, or indeed regarded himself at liberty, to make any alterations in the plan of the work, or to suppress any of the moral reflections which give to the whole so exquisite a charm; but has simply ventured upon a few occasional suppressions or additions, where recent *improvements in* science rendered them necessary to prevent misconception and error. In a few cases, there will be found an additional flower scattered in the way, taken for the purpose from the regions of poetry; but these seem so strictly in accordance with the original plan of the author, that no apology can be requisite for their introduction.

Of the several causes which may be assigned for the wider diffusion of philosophical knowledge among the middle classes of society in Great Britain, none probably can be specified that has been more efficacious than the number and variety of popular books on scientific subjects, drawn up for the instruction of youth. And, from these, again, few can be selected that have contributed more than the *Contemplative Philosopher;* though several performances, now well known to the public, have been evidently formed upon the same model.

The prominent phenomena of Nature, as they are brought under the notice of the observer, in different seasons of the year, and in different portions of the globe, become in succession the topics of contemplation. Of some, the author traces the natural history; of others, developes the cause; of others, explains the use. The principles of the *chemist*, the *astronomer*, the *mechanist*, the *botanist*, the *physiologist*, the *meteorologist*, the *entomologist*, and the *metaphysician*, are, in their turns, laid under contribution; and all made to yield information and pleasure to the ingenious youthful inquirer. In a word, to use the expressive language of our author, in his concluding paper,—the *Contemplative Philosopher* has wandered into some of the most fertile regions of philosophical discussion, and collected a variety of the wonderful phenomena of Nature, as rational subjects of curiosity, and investigation. "My *young readers* in particular," (he continues) "I have endeavoured to allure to these improving inquiries, by strewing, as it were, each winding path with flowers;—showing, at the same time, how much some of the finest passages in poetry are indebted, for their beauty, to the gay and lively, or to the sublime, and even terrific images, which are every where so profusely scattered. But I have deemed this a consideration of infinitely less moment, than that of *inculcating the principles of piety and virtue,* by occasionally introducing such *religious* and *moral reflections* as each subject had a tendency to inspire; and pointing out, as the glorious theme of all, the irresistible indications of a SUPREME BEING, the Great Creator and Governor of Universal Nature."

By selecting for explanation or description such objects and appearances, as are most calculated to impress the inquisitive mind, at the same time that they admit of adequate elucidation without running into abstruse discussions, the author takes the best method, at once of exciting a thirst for useful knowledge, and, to a considerable extent, of gratifying it. In those cases where it was advisable to refer the reader to other authorities for additional information, the author has usually made such references: and the present Editor has adopted a similar plan, whenever the gradual augmentations which are incessantly making to the general stock of philosophical verities, seemed to render it necessary.

On the whole, therefore, it is earnestly hoped that the numerous improvements made in this *new edition* of the Contemplative Philosopher, will render it more extensively beneficial to the rising generation, and insure it a continuance of public encouragement.

It is a common debt of justice to a worthy and ingenious man, to announce that the *Contemplative Philosopher,* though hitherto published anonymously, was written by the late Mr. Richard Lobb, a gentleman who contributed largely to the public instruction and amusement in several performances; but whose great modesty induced him usually to shrink from the commendation which was so justly due to his well directed exertions.

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THE

CONTEMPLATIVE PHILOSOPHER.

No. I.

REFLECTIONS ON WINTER.

Vides, ut alta stet nive candidum
  Soracte, nec jam sustineant onus
Sylvæ laborantes, geluque
  Flumina constiterint acuto! HOR.

See, how Soracte's crown of woods,
  Bows with the spangled loads of snow!
Enthralled by Winter's chain, the floods
  Forget to murmur and to flow. WAKEFIELD.

WHEN Nature, in a state of desolation, seems, to an inattentive eye, to present nothing, as it were, but the creation in distress, the Contemplative Philosopher, as he walks forth to explore the dreary scenes around him, will discover a great variety of phenomena peculiar to this season, with sufficient beauty or usefulness in each to merit a distinct discussion. Whether he contemplates Winter in its first approaches, or enters into a minute investigation of its various scenery; whether he confines his researches to our temperate zone, or makes excursions to the polar regions; each

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subject, separately considered, will afford ample room for poetical illustration and philosophical inquiry.

Of all the poets, ancient or modern, Thomson has exhibited the noblest group of winter imagery. Nor is this to be wondered at in a poet, who, in his earliest years, was fond of viewing nature, not only in her beautiful and smiling aspects, but, like the great Salvator Rosa, in the frowning, the terrific, and sublime. This he intimates himself, at the opening of his poem, in which he introduces Winter approaching with all the gloomy pomp of personification.

> See, Winter comes, to rule the varied year,
> Sullen and sad, with all his rising train:
> Vapours, and clouds, and storms. Be these my theme,
> These! which exalt the soul to solemn thought
> And heavenly musing. Welcome, kindred glooms!
> Congenial horrors, hail! With frequent foot,
> Pleased have I, in my cheerful morn of life,
> When nursed by careless Solitude I lived,
> And sung of Nature with unceasing joy,
> Pleased have I wandered through your rough domain;
> Trod the pure virgin snows, myself as pure;
> Heard the winds roar, and the big torrents burst;
> Or seen the deep fermenting tempest brewed
> In the grim evening sky.

Contemplations of this kind were, indeed, suited to the serious and virtuous soul of Thomson. They raised to nobler heights the fire of poetry and the ardour of devotion; and the winds, and storms, and torrents, led him to exclaim,

> Nature! great parent! whose unceasing hand
> Rolls round the seasons of the changeful year,
> How mighty, how majestic are thy works!
> With what a pleasing dread they swell the soul,
> That sees astonished, and astonished sings!

It is remarkable that the first written of Thomson's Seasons was Winter, and Cowper has dedicated three of the six books of his Task to winter subjects. Hear also the poet, BURNS:—

The weeping blast, the sky o'ercast,
The joyless winter-day,
Let others fear, to me more dear
Than all the pride of May.
The tempest's howl, it soothes my soul,
My grief it seems to join;
The leafless trees my fancy please,
Their fate resembles mine.

Virgil, in a fine specimen of that variety, that magic art which constitutes one of the greatest beauties of poetry, suddenly conveys his reader from the pastoral scenes of Africa to the picturesque horrors of a Scythian winter[1]. Thomson's view of Winter in the polar circle is a noble imitation of this description; but he soars far beyond his master, over deserts of snow, and oceans of ice, to the pole itself. Here again he personifies Winter, and enthrones him in dreadful solitude and magnificent desolation.

Still pressing on beyond Tornea's lake,
And Hecla flaming through a waste of snow,
And farthest Greenland, to the pole itself,
Where, falling gradual, life at length goes out,
The muse expands her solitary flight;
And hov'ring o'er the wide stupendous scene,
Beholds new scenes beneath another sky[2],
Throned in his palace of cerulean ice,
Here Winter holds his unrejoicing court,
And through his airy hall the loud misrule
Of driving tempest is for ever heard;
Here the grim tyrant meditates his wrath;
Here arms his winds with all-subduing frost;
Moulds his fierce hail, and treasures up his snows,
With which he now oppresses half the globe.

In a general view of winter, in this country, I shall not attempt to give a philosophical account of the various phenomena peculiar to this inclement season; nor shall I pursue my researches, at present, into more northern regions.—Winter has been defined to be that season of the year in which the days are shortest. It commences on or about the 22d of December, which is called the Winter Solstice, being that day when the sun's distance from the zenith of the place is greatest; and it ends on the 20th of March, when its distance is at a mean between the greatest and the least; that is, at the time of the equinox. But I shall only observe further, that notwithstanding the coldness of this season, it has been demonstrated by astronomers, that the sun is really nearer to the earth in winter than in summer. The principal cause of this difference is, that in winter the sun's rays fall so obliquely upon us, and have so large a portion of the atmosphere to pass through, that any given number of them is spread over a much greater portion of the earth's surface where we live; and therefore each point must then have fewer rays than in summer, or when the sun is at a greater height above the horizon. There comes, moreover, a greater degree of cold in the long winter nights, than can be compensated for by the return of heat in the short days; and, on both these accounts, the cold must necessarily increase. In summer, on the contrary, the rays of the sun fall more perpendicularly upon us, and therefore strike with greater force and in greater numbers on the same place, than when they come more obliquely; and by the longer continuance of the sun above the horizon than in winter, a much greater degree of heat is imparted by day than can fly off by night, so that the heat must increase.

---

[1] Quid tibi pastores Lybiæ, &c. GEORG. III. 319.
[2] *The other* hemisphere.

Severe and rigorous as winter is described to be, its various scenes, however, cannot fail to suggest many subjects of gratitude to the Contemplative Philosopher. Few minds are so devoid of sensibility, as not to experience the most grateful emotions, when the inexhaustible bounties of the Supreme Being bloom around in spring, in beautiful profusion; delight the eye in summer with maturing promise; and ripen in autumn into rich and exquisite perfection. In general, even in minds not unsusceptible in other respects, we seldom find a disposition to grateful admiration, when they behold the ravages in the creation; the orchards stripped of their golden fruits; and harmony extinct in the groves, now bending with the snow, 'their beauty withered, and their verdure lost.'

No mark of vegetable life is seen,
No bird to bird repeats his tuneful call,
Save the dark leaves of some rude evergreen,
Save the lone red-breast on the moss-grown wall.
JOHN SCOTT.

In the beautiful invitation to a redbreast by Vincent Bourne, translated by the amiable Cowper, are the following appropriate lines:

Sweet bird, whom the winter constrains--;
And seldom another it can—
To seek a retreat while he reigns,
In the well-sheltered dwelling of man.
Who never can seem to intrude,
Tho' in all places equally free,
Come oft' as the season is rude!
Thou art sure to be welcome to me.

The poet, having 'promised a feast at his windows,' and convinced of being 'paid with a song,' thus beautifully proceeds:

Then, soon as the swell of the buds
Bespeaks the renewal of spring,
Fly hence, if thou wilt, to the woods,
Or where it shall please thee to sing:

And should'st thou, compelled by a frost,
Come again to my window or door,
Doubt not an affectionate host,
Only pay as thou pay'dst me before [1].

But the benign Governor of the universe, who has subjected his creatures to the rigours of this season, has graciously enabled them to mitigate its severity by a variety of resources. The woods, which, in spring, crowned the hills with majestic verdure, now contribute to erect the comfortable mansion; or, added to what is extracted from the bowels of the earth, afford us the unspeakable blessing of fire. The flocks, which no longer gladden our plains, nor, to the poetic eye, revive Arcadian scenes, have given us their summer fleeces to protect us from the piercing cold; and the fruits with which autumn adorned our orchards, are now laid up, with its golden harvests, for our nourishment and support. In a word, the devout mind may have reason, even in winter, to exclaim with the Psalmist, '*O Lord, how manifold are thy works! In wisdom hast thou made them all: the earth is full of thy riches.*'

Had it been given to us mortals to comprehend the connection of every thing in nature, with what fervour of admiration should we adore the wisdom and goodness of the great Creator! But although we are incapable of forming an idea of the plan and extent of his wondrous works (those works which display infinity in the two extremes of magnitude and minuteness), we may yet perceive enough to convince us, that, with respect to the happiness of the whole, every thing in nature must be ultimately ordered for the best. Winter belongs not less to the divine plan than the more pleasing seasons of the year. Were there no winter, neither the spring, nor summer, nor autumn, would display such a variety of beauties; for the earth itself would lose those rich stores of nourishment and fertility, to which even the winter so copiously contributes.

---

[1] For the remainder of this translation, and the no less exquisite original, see *Cowper's Poems*, vol. iii. p. 355.

The felicities of the golden age are beautiful in poetic vision. A youthful fancy is delighted with fruits and blossoms blushing, 'in social sweetness, on the self-same bough.' It wanders, with ecstasy, through groves adorned with perennial verdure, while Favonian gales perfume the ever-smiling skies. But these are the enchanted reveries of fiction, not the sober representations of truth. The human mind, which seems ever anxious for new gratifications, would revolt at the idea of perpetual sameness and uniformity, even in the most beautiful scenes and the most exquisite enjoyments. One can have no idea of happiness, when it does not, in some degree, result from comparison: for not only variety contributes much to our sense of happiness, but not unfrequently a recollection of former calamities, or of some recent suffering. That degree of ease which we scarcely regard in the full enjoyment of health, is ecstacy itself, when pain has taught us how to prize the inestimable blessing. In the moral world 'how sweet are the uses of adversity,' which best instruct us how to estimate and how to enjoy prosperity! In like manner, the recollection of the frowning skies of winter will make us rejoice in the return of that spring, in whose flowery walks, if perpetual, we should have trod with languor and indifference. More cheerily will the heart then dance to the music of the groves, when it recollects how recently their tuneful haunts were dumb. Brighter, then, will be the verdant robes which the woods assume, contrasted with *their late leafless* and inhospitable appearance; and, as 'hope waits upon the flowery prime,' the fruits and flowers, when they bud, will delight the fancy, in sweet anticipation, with all the pride of summer, and all the riches of autumn. The rigours of departed winter will be forgotten in that all-enlivening renovation of Nature. In fine, our hearts, then attuned to cheerfulness and gaiety, will confess this important truth, that 'as Providence has made the human soul an active being, always impatient for novelty, and struggling for something yet unenjoyed with unwearied progression, the world seems to have been entirely adapted to this disposition of the mind: it is formed to raise expectation by constant vicissitudes, and to obviate satiety with perpetual change.'

No. II.

ON WINDS AND STORMS.

> Ingeminant austri, et densissimus imber:
> Nunc nemora ingenti vento, nunc littora plangit,
> VIRGIL.
>
> The winds redouble, and the rains augment:
> The waves on heaps are dashed against the shore,
> And now the woods, and now the billows roar.
> DRYDEN.

AS Winter unfolds his awful train, 'vapours, and clouds, and storms,' the Contemplative Philosopher becomes habituated to views of the stupendous and sublime. Verdant groves, variegated meadows and radiant skies, are now succeeded by leafless woods, dejected wastes, and a frowning *atmosphere.* But while the incurious and inattentive mind perceives a dreary uniformity in all around, the penetrating eye of the rural student discovers many a varied aspect of beauty and excellency, which still invite to the most pleasing investigation. And, however paradoxical it may appear, he finds inexhaustible sources of serenity and delight, in that mood of melancholy musing on scenes of desolation, which, in vulgar estimation, would rather

> Deepen the murmur of the falling floods,
> And breathe a browner horror o'er the woods.
>
> POPE.

In fine, in each vicissitude of the seasons, he still discerns the omnipotent Creator, ever bountiful to man; and, whether the gentle gales breathe propitious in spring, or resistless storms ravage the earth in winter, his cultivated mind kindles with devotion, and even calls upon the inanimate world to join him in adoration:

> To him, ye vocal gales,
> Breathe soft, whose spirit in your freshness breathes:
> Oh, talk of Him in solitary glooms!
> Where, o'er the rock, the scarcely waving pine
> Fills the brown shade with a religious awe.
> And ye, whose bolder note is heard afar,
> Who shake the astonished world, lift high to Heav
> The impetuous song, and say from whom you rage.
>
> THOMSON

In the subject of my preceding essay, I had a satisfaction in exhibiting some of those admirable pictures, which the great poets and painters of Nature have been found to trace. I next entered, with the natural philosopher, into a disquisition concerning those wonderful vestiges of beauty and usefulness, of wisdom and contrivance, which not only demonstrate a Creating Hand, but demonstrate that Hand to be Divine. And finally, with the religious and *sentimental* reader, I indulged such moral reflections as the subject had a tendency to inspire. This is the order, which, once for all, I mean to pursue in my future lucubrations, and by which I hope to gratify alike the poet, the philosopher, and the christian.

The subject, hitherto, has been chiefly confined to what the surrounding country affords; but we are now carried to the distant ocean.

> Wide o'er the moving wilderness of waves,
> From pole to pole through boundless space diffused,
> Magnificently dreadful! MALLET.

Virgil, in the first book of his Æneid, gives the description of a storm, which, as Mr. Spence observes, probably set all the Roman poets a storm-painting. Thomson also gives a minute and picturesque description, with circumstances more natural to the English reader, especially in the various passages that announce the approaching tempest[1].

To account, philosophically, for the cause of winds, we must have recourse to the elasticity of the air, that property which renders it capable of compression and expansion. This elasticity is increased by heat, which rarefies and expands the air; and of this property, the wind is a necessary consequence: for, when the atmosphere is heated over one part of the earth more than over another, the warmer air, in this case, being rarefied, becomes specifically lighter than the rest. It is therefore overpoised by it, and raised upward; the upper parts of it diffusing themselves every way over the top of the atmosphere; while the neighbouring inferior air rushes in from all parts at the bottom; which it continues to do, till the equilibrium is restored. Upon this principle it is that most of the winds may be accounted for. Hence, moreover, we may account for the rushing of the air into a glasshouse, or toward any place where a great fire is made; for the ascending of smoke up a chimney; and for a circumstance so little attended to, as the rushing of the air through the keyhole of a door, or any small chink, when there is a fire in the room. Nor is this mere speculation, or conjecture: for the truth of this general observation, that the air will press toward that part of the world where it is most heated, has been demonstrated beyond any kind of doubt, by the following very simple experiment. Fill a large dish with cold water: into the middle of this put a water-plate filled with warm water. The first may represent the ocean, and the other an island rarefying the air about it. Blow out a wax candle, and if the place be still, on applying it successively to every side of the dish, the smoke will be seen to move toward the plate. Again, if the ambient water be warmed, and the plate filled with cold water, let the smoking wick of the candle be held over the plate, and the very reverse will happen.

---

[1] See his Winter, line 118 to 201.

Under the equator, the wind is always observed to blow from the east point. For, supposing the sun to continue vertical over some one place, the air will be most rarefied there; and, consequently, the neighbouring air will rush in from every quarter with equal force. But, as the Sun is continually shifting to the westward, the part where the air is most rarefied is carried the same way; and therefore the tendency of all the lower air, taken together, is greater that way than any other. Thus the tendency of the air toward the west becomes general; and its parts impelling one another, and continuing to move till the next return of the sun, so much of its motion as was lost by his absence is again restored; and, therefore, the easterly wind becomes perpetual.

On each side *of the equator*, to about the 30th degree of latitude, the wind is found to vary from the east point, so as to become northeast on the northern side, and south-east on the southern. The reason of this is, that, as the equatorial parts, are hotter than any other, both the northern and southern air ought to have a tendency that way; the northern current, therefore, meeting in this passage with the eastern, produces a north-east wind on that side; as the southern current joining with the same, on the other side of the equator, forms a south-east wind there.

This is to be understood of open seas, and of such parts of them as are distant from the land; for near the shores, where the neighbouring air is much rarefied, by the reflection of the sun's heat from the land, it frequently happens otherwise; particularly on the coast of Guinea, where the wind always sets in upon the land, blowing westerly instead of easterly. This is occasioned by the deserts of Africa, which lying near the equator, and having a very sandy soil, reflect a greater degree of heat into the air above them; which being thus rendered lighter than the air which is over the sea, the wind continually rushes in upon the land, to restore the equilibrium.

That part of the ocean which is called the Rains, is attended with perpetual calms, the wind scarcely blowing sensibly either one way or the other. For this tract being placed between the westerly wind blowing from the ocean toward the coast of Guinea, and the easterly wind blowing from the same coast to the westward thereof, the air stands in equilibrium between both; and its gravity is so much diminished thereby, that it is not able to support the vapour it contains, but lets it fall in con tinual rain; and hence this part of the ocean receives its name.

There is a species of winds observable in some places between the tropics, called Monsoons, or Trade Winds, which, during six months of the year, blow one way, and the remaining six the contrary. The cause of them, in general, is this: when the sun approaches the northern tropic, there are several countries, as Arabia, Persia, India, &c. which become hotter, and reflect more heat than the seas beyond the equator, which the sun has left; the winds, therefore, instead of blowing thence to the parts under the equator, blow the contrary way; and when the sun leaves those countries, and draws near the other tropic, the winds turn about, and blow on the opposite point of the compass.

From the solution of the general trade winds, we may see the reason why, in the Atlantic ocean, a little on this side the 30th degree of north latitude, there is generally a west or south-west wind. For, as the inferior air within the limits of those winds is constantly rushing toward the equator, from the north-east point, or nearly so, the superior air moves the contrary way; and, therefore, after it has reached these limits, and meets with air, that has little or no tendency to any one point more than to another, it will determine this air to move in the same direction with itself.

In our own climate we frequently experience, in calm weather, gentle breezes blowing from the sea to the land, in the heat of the day; which phenomenon is very agreeable to the principle laid down above: for the inferior air over the land being rarefied by the beams of the sun reflected from its surface, more than that which impends over the water, the latter is constantly moving on to the shore, in order to restore the equilibrium, when not disturbed by stronger winds from another quarter. And hence, in hot countries, the sea breezes almost invariably blow from sea to land, in the day-time; and the land breezes, on the contrary, in the night.

From what has been observed, nothing is more easy than to see, why the northern and southern parts of the world, beyond the limits of the trade winds, are subject to such variety of winds. For the air, on account of the smaller influence of the sun in those parts, being undetermined to move toward any fixed point, is continually shifting from place to place, in order to restore the equilibrium, wherever it is destroyed; whether by the heat of the sun; the rising of vapours, or exhalations; the falling of great quantities of rain, or the melting of the snow upon the mountains, either of which causes a sudden condensation or compression of the air; or by high mountains, which alter the direction of the winds. For to these, not to mention other circumstances, we may trace the origin of all those storms, hurricanes, whirlwinds, and irregularities, which happen at different times and places[1].

From this account of the nature and causes of the winds, it is natural to advert to their various uses in the material world. And, here, the superficial observer may inquire, how it happens, that, with such evident marks of wisdom and contrivance in the objects we have hitherto surveyed, a Being infinitely good, as well as wise and powerful, could permit such a variety of evils as are produced by storms and tempests; by which whole countries have been ravaged, and thousands, in every age, overwhelmed in the ocean. To this it may be observed, that nothing is properly an *evil*, which it is consistent with the perfections of the Deity to permit or appoint, but what deserves that character *upon the whole*. This we can never presume to say of any thing we are acquainted with, nor, indeed, of any natural evils that are of a limited duration. It is more becoming to suppose, that they may have a tendency to promote the more solid and permanent happiness of *individuals* (after several intermediate consequences, which we are too short-sighted to trace) as well as the *general good* of the creation. Nor can we demonstrate, or even argue the contrary, with any probability, unless we can likewise comprehend all the infinite variety of designs, that an all-wise Being may intend to effect, by particular occurrences, and thoroughly understand the whole plan of his government, the connection of the several parts of it, and their reference and subordination to each other.

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[1] This account of the winds corresponds, in the main, with the theory of Dr. Halley. Another hypothesis has been advanced by Mr. Dalton, in his Meteorological Essays; but it does not appear to us preferable to the one here adopted.

> 'Tis but a part we see, and not a whole. POPE.

It must, at least, be unquestionable, that what seems wrong in the present state, may be amply rectified in some future scene of existence, and the present evil infinitely overbalanced by the succeeding good.

It may further be observed, with the poetical philosopher just quoted, that 'all partial evil is universal good.' Of what we call natural evils, many are most admirably adapted to the preservation and welfare of the creation.

> In thy world material, mighty mind!
> Not that alone which solaces and shines,
> The rough and gloomy, challenges our praise,
> The winter is as needful as the spring;
> The thunder as the sun: a stagnant mass
> Of vapours breeds a pestilential air:
> Not more propitious the Favonian breeze
> To Nature's health, than purifying storms. YOUNG.

In a word, the more attentively we consider this subject, the Contemplative Philosopher cannot but learn this important truth, that, from the natural evils incident to the present frame and constitution of things, the Divine Being either is constantly educing good, or will, finally, render them subservient, on the whole, to the happiness of his creatures. Nor can a benevolent mind derive a nobler consolation in calamity, than from the consideration, that the immediate cause of his sufferings may, perhaps, in the providential course of events, be conformable to some gracious intention in that Being, who is the inexhaustible fountain of good to all his creatures; and that not only the winds, in general, are productive of various benefits to mankind, but that the very storm, which perhaps ravaged his lands, or plunged some loved relative in the deep, was necessary to ventilate the skies, to agitate the ocean into wholesome rage, and to sweep from the earth those noxious vapours, which, if permitted to be at rest, would be productive of all the fatal effects of infection and disease. And with respect to himself, as an individual, he will rejoice in the reflection, that after a few years more, spent in the aspiring hopes of faith and piety[a], the benevolent exertions of virtue and goodness, and the patient exercise of fortitude and resignation, all the momentary evils of this life will be succeeded by unfading peace and everlasting joy:

The storms of wintry life will quickly pass,
And one unbounded spring encircle all. THOMSON.

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[a] Hope humbly then; with trembling pinions soar;
Wait the great teacher Death; and God adore.
POPE.

No. III.

ON SNOW.

Why hover snows, and wanton in the air,
Fall by degrees, and clothe the hoary year?
BROOME.

He gives the winter's snow her airy birth,
And bids her virgin fleeces clothe the earth.
SANDYS.

AMONG the various phenomena of winter, not one is more worthy of discussion than that of snow, which is, confessedly, one of the most curious productions of Nature, and, in the remotest ages of antiquity, has excited the admiration of the poets and philosophers, whether sacred or profane. The author of the book of Job, in the discourse which he puts into the mouth of Elihu, concerning the glorious and incomprehensible works of the Deity, thus expresses himself: '*God thundereth marvellously with his voice: great things doeth he, which we cannot comprehend; for he saith to the snow, Be thou on the earth.*'—And he represents the omnipotent Jehovah, in his sublime expostulation with the patriarch, thus demanding: '*Hast thou entered into the treasures of the snow, or hast thou seen the treasures of the hail, which I have reserved against the time of trouble, against the day of battle and war?*"—'*He giveth,*' says the Psalmist, '*snow like wool: he scattereth the hoar-frost like ashes. He casteth forth his ice like morsels: who can stand against his cold?*'—'*At his commandment,*' says the wise son of Sirach, '*he maketh the snow to fall apace—As birds flying he scattereth the snow, and the falling down thereof is as the lightning of grasshoppers.* The eye mar-

velleth at the beauty of the whiteness thereof, and the heart is astonished at the raining of it.'

Homer, the venerable sire of bards, has described a shower of snow, and its extensive effects, in a noble strain of poetry:

> In Winter's bleak uncomfortable reign,
> A snowy inundation hides the plain;
> *Jove* stills the winds, and bids the skies to sleep;
> Then pours the silent tempest thick and deep:
> And first the mountain tops are covered o'er,
> Then the green fields, and then the sandy shore;
> Bent with the weight the nodding woods are seen,
> And one bright waste hides all the works of men:
> The circling seas alone, absorbing all,
> Drink the dissolving fleeces as they fall. POPE.

Aristotle's definition of snow and hail is concise and just: 'Snow is a cloud congealed, and hail congealed water.' Pliny calls snow 'the foam of celestial waters when they dash against one another.' This is very ingeniously expressed for a poet, but it is not the definition of a philosopher. Lucretius enumerates snow among a variety of phenomena, the causes of which, he says, it is easy to investigate. He is content, however, to leave the subject to the sagacity and researches of his readers:

> Cætera, quæ sursùm crescunt, sursùmque creantur:
> Et quæ concrescant in nubibus omnia, prorsùm
> Omnia, nix, venti, grando, gelidæque pruinæ,
> Et vis magnus geli, magnum duramen aquarum;
> Et mora, quæ fluvios passim refrenat euntes;
> Per facile'st tamen hæc reperire, animoque videre
> Omnia quo pacto fiant, quareve creantur,
> Cum bene cognôris, elementis reddita quæ sint.
>
> Meteors, that high ascend the aerial way,
> Or float in clouds, and various forms display;
> The snow that whitens over all the ground;
> The winds that wide spread desolation round;
> The rattling hail; and beauteous-fancied frost,
> With hoary charms on every plant embost;
> The ice, whose mighty force pervades the woods,
> *Binds* deep the earth, and stops the rapid floods;

Of these, how easy 'tis to trace the cause,
When once you know, when once conceive their laws[1].

But we need not consult the antients, either for the beauties of poetical illustration, or the acquisitions of philosophical inquiry, while we can have recourse to our own admirable poet of the Seasons. What can be more minutely circumstantial, or more elegantly accurate, than the following description?

The keener tempests rise: and, foaming dun
From all the livid east, or piercing north,
Thick clouds ascend; in whose capacious womb
A vapoury deluge lies, to snow congealed.
Heavy they roll their fleecy world along;
And the sky saddens with the gathered storm.
Thro' the hushed air the whitening shower descends,
At first thin wavering; till, at last, the flakes
Fall broad, and wide, and fast, dimming the day,
With a continual snow. The cherished fields
Put on their winter robe of purest white.
'Tis brightness all; save where the new snow melts
Along the mazy current. Low, the woods
Bow their hoary head; and, ere the languid sun
Faint from the west emits his evening ray,
Earth's universal face, deep hid, and chill,
Is one wide dazzling waste, that buries wide
The works of man.

The limits of this paper will not allow me to proceed to the poet's account of the effects which the inclemency of the season has upon animals, and particularly the feathered tribes, while the snow is upon the ground; nor to his description of the driving of the snows, by which whole flocks of sheep are sometimes overwhelmed; nor to his exquisite episode of a man perishing in the snow. But in this last there is a circumstance described, so truly original, so natural and pathetic, that I cannot forbear to quote it.

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[1] And how the other meteors rise and fall,
What stamps the figured snow and moulds the hail,
And why the water's pride and beauty's lost,
When rig'rous winter binds the floods with frost,
'Tis easy to conceive, if once we know
The nature of the elements, or how
Their fighting powers must work, or what they do.

CREECH.

> In vain for him the officious wife prepares
> The fire fair-blazing, and the vestment warm;
> In vain his little childen, peeping out
> Into the mingling storm, demand their sire,
> With tears of artless innocence. Alas!
> Nor wife, nor children, more shall he behold,
> Nor friends, nor sacred home!

With respect to the philosophical account of this well-known meteor, naturalists are agreed that it is formed by the freezing of the vapours in the atmosphere. The snow we receive may, properly enough, be ascribed to the coldness of the atmosphere through which it falls. When the atmosphere is warm enough to dissolve the snow, before it arrives to us, we call it rain; if it preserve itself undissolved, it makes what we call snow. It differs from the particles of hoar-frost, in being crystallized, as it were, which they are not. This appears on the examination of a flake of snow by a magnifying glass; when the whole of it will seem composed of fine shining spicula, or points, diverging like rays from a centre. As the flakes fall down through the atmosphere, they are continually joined by more of these radiated spicula, and thus increase in bulk like the drops of rain or hail-stones. Dr. Grew, in a discourse on the nature of snow, observes, that many parts of it are of a regular figure, for the most part so many little rowels or stars of six points, and are as perfect and transparent ice as any we see on a pond. Upon each of these points are other collateral points, set at the same angles as the main points themselves:

among which there are divers others irregular, which are chiefly broken points, and fragments of the regular ones. Others also, by various winds, seem to have been thawed, and frozen again into irregular clusters; so that it seems as if the whole body of snow was an infinite mass of icicles irregularly figured. That is, a cloud of vapours being gathered into drops, those drops forthwith descend, and, in their descent, meeting with a freezing air as they pass through a colder region, each drop is immediately frozen into an icicle, shooting itself forth into several points; but these, still continuing their descent, and meeting with some intermitting gales of warmer air, or, in their continual waftage to and fro, touching upon each other, are a little thawed, blunted, and frozen into clusters, or entangled so as to fall down in what we call flakes.

According to Signore Beccaria, clouds of snow differ in nothing from clouds of rain, but in the circumstance of cold that freezes them. Both the regular diffusion of snow, and the irregularity of the structure of its parts (particularly some figures of snow or hail, which he calls *rosette*, and which fall about Turin), show the clouds of snow to be acted upon by some uniform cause, like electricity. He even endeavours, very particularly, to show in what manner certain configurations of snow are made by the uniform action of electricity. He was confirmed in his reasonings on this subject by observing, that his apparatus never failed to be electrified by snow as well as by rain; and, he adds, that a more intense electricity unites the particles of hail more closely than the more moderate electricity does those of snow.

Snow, although it seems to be soft, is really hard, because it is true ice. It seems soft, because, at the first touch of the finger upon its sharp edges or points, they melt; otherwise they would pierce the finger like so many lancets.

Dr. E. D. Clarke, in his Travels (vol. i. p. 11), records a very curious and beautiful phenomenon, which he witnessed before the breaking up of the winter season at St. Petersburgh. 'Snow, in the most regular and beautiful crystals, fell gently on our clothes, and on the sledge, as we were driving in the streets: all of them possessed exactly the same figure, and the same dimension. Every particle consisted of a wheel or star, with six equal rays bounded by circumferences of equal diameters: they had all of them the same number of rays branching from a common centre. The size of each of these little stars was equal to the circle presented by dividing a pea into two equal parts. This appearance continued during three hours, in which time no other snow fell, and there was sufficient leisure to examine them with the strictest attention.' As water, in its crystallization (continues Dr. Clarke), seems to consist of radii diverging from a common centre, by the usual appearances ou the surfaces of the ice, it might be possible to obtain the theory and ascertain the laws from which this stellar structure results. Monge, president of the French Institute, noticed, in falling snow, stars with six equal rays, which fell during winter, when the atmosphere was calm. This is also recorded by Haüy. Dr. Clarke has accompanied this description with three wood-cuts, to which we refer the curious reader.

The lightness of snow, although it is firm ice, is owing to the excess of its surface, in comparison to the matter contained under it; and thus gold, the most ponderous of all bodies, when beaten into leaves, will ride upon the least breath of air. The whiteness of snow is owing to the small particles into which it is divided; for ice, when pounded, will become equally white. An artificial snow has been made by the following experiment. A tall phial of aqua fortis being placed by the fire till it is warm; and filings of pure silver, a few at a time, being put into it; after a brisk ebullition, the silver will dissolve slowly. The phial then being placed in a cold window, as it cools, the silver particles will shoot into crystals, several of which running together, will form a flake, resembling snow, and descend to the bottom of the phial. While they are descending, they represent perfectly a shower of silver snow, and the flakes will lie upon one another at the bottom, like real snow upon the ground. In a word, a shower of snow, although so common with us, and therefore so little regarded, is, in itself, a most beautiful spectacle, and is considered by the natives of southern climes, on their arrival here, as the most extraordinary and amazing phenomenon of nature.

But we are not to consider snow merely as a curious and beautiful phenomenon. The great Dispenser of universal bounty has so ordered it, that it is eminently subservient, as well as all the works of creation, to his benevolent designs. Were we to judge from appearances only, we might imagine, that so far from being useful to the earth, the cold humidity of snow would be detrimental to vegetation. But the experience of all ages asserts the contrary. Snow, particularly in those northern regions where the ground is covered with it for several months, fructifies the earth, by guarding the corn, or other vegetables, from the intenser cold of the air, and especially from the cold piercing winds. It has been a vulgar opinion, very generally received, that snow fertilizes the lands on which it falls more than rain, in consequence of the nitrous salts which it is supposed to acquire by freezing[1]. But it appears from the experiments of Margraaf, in the year 1751, that the chemical difference between rain and snow-water is exceedingly small; and that the latter, however, is somewhat less nitrous, and contains a somewhat less proportion of earth, than the former; but neither of them contain either earth or any kind of salt, in any quantity, which can be sensibly efficacious in promoting vegetation. Allowing, therefore, that nitre is a fertilizer of lands, which many are, upon good grounds, disposed utterly to deny, yet so very small is the quantity of it contained in snow, that it cannot be supposed to promote the vegetation of plants upon which the snow has fallen.

On the uses of snow we add some further particulars, which the researches of modern science have brought to light. 'All those who inhabit parts of the earth exposed to snow, agree in considering it as one of the means employed by nature to give plants more strength, and make them expand with more vigour. Several are even persuaded that winters, producing no snow, presage a bad harvest, and a feeble state of vegetation; and they ascribe its influence to the salts, which they say exist in congealed water. That, after a very severe and cold winter, plants should be stronger and more active in proportion as they may have been covered with snow, is proved by the experience of every one engaged in agriculture. The cause is simple and natural. All plants are capable of supporting cold in a greater or less degree. There are some which cannot be exposed to the temperature of melting ice without perishing, while there are others in which the most intense cold makes no alteration. Each plant has certain limits as to its resistance of cold, a certain temperature beyond which it cannot go, without the danger of being frozen and destroyed. The earth, as is now well known, has heat accumulated in its interior parts: this heat is perceived in all subterraneous places of sufficient depth to prevent the external heat or cold from entering. Snow is a bad conductor of heat, cold penetrates it with difficulty; and its temperature, when it melts, is zero. When the earth is covered to a considerable depth with snow, the cold of the atmosphere, in contact with it, tends to cool its mass; the internal heat of the earth tends to warm it. Throughout the mass of snow there is a strong contest between the heat and cold; a portion of the snow is melted and carried to zero, the medium temperature, wherein the plants are situated.

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[1] THOMSON falls into this popular error.

Thro' the blue serene,
For sight too fine, th' *etherial* NITRE flies;
Killing infectious damps, and the spent air
Storing afresh with elemental life.

'The snow has the properties of keeping the plants it covers at the temperature of melting ice; of preserving them from the influence of a greater cold; of supplying them with continual moisture; of preventing a great number perishing, and still more from languishing; and, consequently, of imparting more strength and vigour to vegetation. It appears, then, that we may explain a part of the influence snow has upon vegetation, without having recourse to the salts or nitre which it is said to contain, but which analysis and experiments have proved do not exist. It has also been demonstrated by experiment, that snow is oxygenated water; that, in the germination of seeds in particular, the presence and contact of oxygen are absolutely necessary for the plant to expand; and that, in proportion to the abundance of oxygen, the more rapidly the seeds will grow.

'Most plants, permitted to attain their perfect maturity, shed on the earth a part of their seeds, which, thus abandoned and exposed to the action of cold, are covered and preserved by the snow. At the same time they find in the water the snow produces by melting, a portion of oxygen, which has a powerful effect on the principle of germination, and determines the seed, which would have otherwise perished, to grow, to expand, and to augment the number of plants that cover the surface of the earth.

'A very considerable number of the plants we have the art of appropriating for our nourishment and wants, are sown from the end of September to the end of December. Several of them germinate before the cold commences its influence upon them, and changes the principle of their life. The snow which covers the rest, acting on their germs by its oxygenation, compels them to reward the trouble of the farmer and gardener, and multiply the quantity of useful productions.

'The influence of snow on vegetation cannot be better summed up, than by saying that, in the first place, it protects the plants and the seeds from the violence of the frost; in the second, furnishes them with a continual moisture; and in the third, makes a greater number of seeds to germinate[1].'

What themes of grateful adoration does the discussion of this subject suggest! But I will leave my readers, 'in expressive silence,' to 'muse the praise' of the great Creator; and shall conclude with that beautiful emblem, under which e is supposed, by the prophet Isaiah, to represent the salutary efficacy of his divine word: '*As the rain cometh down, and the snow from eaven, and returneth not thither, but watereth the arth, and maketh it bring forth and bud, that it ay give seed to the sower and bread to the eater; o shall my word be that goeth forth out of my mouth: t shall not return unto me void, but shall accomlish that which I please, and it shall prosper in the hing whereunto I sent it.*'

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[1] See Gent. Mag., vol. lxxxiv, part 2, p. 544.

No. IV.

ON WINTER IN THE POLAR REGIONS.

Our infant Winter sinks,
Divested of his grandeur, should our eye
Astonished shoot into the frigid zone:
Where, for relentless months, continual night
Holds o'er the glitt'ring waste her starry reign.
THOMSON.

There Winter, armed with terrors here unknown,
Sits absolute on his unshaken throne;
Piles up his stores amid the frozen waste,
And bids the mountains he has built, stand fast;
Beckons the legions of his storms away
From happier scenes to make the land a prey;
Proclaims the soil a conquest he has won,
And scorns to share it with the distant sun.
COWPER.

WINTER, in our temperate regions, exhibits very few phenomena, in comparison with what is visible in the arctic circle. Thomson, therefore, has judiciously enriched his noble conclusion of the Seasons with all the circumstances of pic turesque beauty, or terrific grandeur, that could be borrowed from scenes far remote from us. The famished troops of wolves pouring from the Alps; the mountains of snow rolling down the precipices of the same countries; the dreary plains over which the Laplander urges his reindeer; the wonders of the icy sea; and volcanoes flaming through a waste of snow; are objects selected, with the greatest propriety, from all that nature presents most singular and striking in the various domains of boreal cold and desolation.

Among the wintry objects which delight the mind by their beautiful and picturesque appearance, we may often observe the effects of the hoar-frost, or of the dew or mist frozen. This adheres to every object on which it falls, and produces figures of incomparable beauty and elegance. Every twig and blade of grass is beset by it with innumerable glittering pearly drops, or silver plumage, beyond the skill of any artist to imitate. These appearances are still more striking, the farther we proceed to the north. It sometimes happens, that a sudden shower of rain falls during a frost, and immediately turns to ice. Philips, in his Epistle from Copenhagen, has given a beautiful description of such a scene: a description which forms as fine a winter piece as we have ever had from the schools of the most exquisite painters:

> Ere yet the clouds let fall the treasured snow,
> Or winds began thro' hazy skies to blow,
> At evening a keen eastern breeze arose,
> And the descending rain unsullied froze.
> Soon as the silent shades of night withdrew,
> The ruddy morn disclosed at once to view
> The face of nature in a rich disguise,
> And heightened every object to my eyes:
> For every shrub, and every blade of grass,
> And every pointed thorn, seemed wrought in glass;

In pearls and rubies rich the hawthorns show,
While thro' the ice the crimson berries glow:
The thick-sprung reeds the wat'ry marshes yield,
Seem polished lances in a hostile field.
The stag, in limpid currents, with surprize,
Sees crystal branches on his forehead rise:
The spreading oak, the beech, the towering pine,
Glazed over, in the freezing ether shine.
The frighted birds the rattling branches shun,
Which wave and glitter in the distant sun.
When, if a sudden gust of wind arise,
The brittle forest into atoms flies,
The crackling wood beneath the tempest bends,
And in a spangled shower the prospect ends.

In such a case, prodigious mischief had been done to the woods, by the breaking down of vast arms of trees which were overloaded by the pressure of the encrusting ice. At other times, the seeming enchantment has been dissolved in a more gentle way:

For if a southern gale the region warm,
And by degrees unbind the wintry charm,
The traveller a miry country sees,
And journeys sad beneath the dropping trees.

As we advance farther into the arctic regions, we find them distinguished by more beautiful appearances of that phenomenon which we call the *aurora borealis.* In Shetland, these northern lights, which the natives call *merry dancers,* are the constant attendants of the clear evenings, and prove great reliefs amid the gloom of the long winter nights. They commonly appear at twilight, near the horizon, of a dun colour, approaching to yellow; sometimes continuing in that state for several hours, without any apparent motion; after which they break out into streams of stronger light, spreading into columns, and altering slowly into ten thousand different shapes, varying their colours from all the tints of yellow to the most obscure russet. They often cover the whole hemisphere, and then make the most brilliant appearance. Their motions, at these times, are most amazingly quick; and they astonish the spectator with the rapid change of their form. They break out in places where none were seen before, skimming briskly along the heavens. On a sudden they are extinguished, and leave behind a uniform dusky tract.

This again is illuminated in the same manner, and as suddenly left a dull blank. In certain nights they assume the appearance of vast columns; on one side of the deepest yellow, on the other declining away till it becomes undistinguished from the sky. They have generally a strong tremulous motion from end to end, which continues till the whole vanishes. In a word, we, who only see the extremities of these northern phenomena, have but a faint idea of their splendour and their motions.

In Siberia, there is one species of the aurora borealis, which regularly appears between the north-east and east, like a luminous rainbow, with numbers of columns of light radiating from it. Beneath the arch is a darkness, through which the stars appear with some brilliancy. This species is thought by the natives to be a forerunner of storms. There is another kind, which begins with certain insulated rays, from the north, and others from the north-east. They augment little by little, till they fill the whole sky, and form a splendour of colours rich as gold, rubies, and emeralds; but the attendant phenomena strike the beholders with horror; for they crackle, sparkle, hiss, make a whistling sound, and a noise even equal to artificial fire-works. The idea of an electrical cause is so strongly impressed by this description, that few persons retain any doubt of the origin of these appearances. The inhabitants on this occasion, say it is a troop of men furiously mad, which are passing by. Every animal is struck with terror. Even the dogs of the hunters are seized with such dread, that they will fall on the ground, and become immoveable, till the cause is over.

In Hudson's Bay, moreover, the firmament, in winter, is not without its beauties. The night is enlivened by the aurora borealis, which spreads a thousand different lights and colours over the whole concave of the sky, not to be defaced even by the splendour of the full moon; and the stars are of a fiery redness. Mock suns and halos are not infrequent; they are very bright, and richly tinged with all the colours of the rainbow. The sun also rises and sets here with a large cone of yellowish light[1].

Philosophers have speculated more frequently than successfully, upon the theory of the aurora borealis. The most satisfactory, which has yet been proposed, though that is not entirely free from objections, is the one of M. Libes. It has, however, been adopted by most of the northern philosophers, and may be concisely stated thus: The production of hydrogenous gas is next to nothing at the poles; therefore so often as the electricity is put into an equilibrated state in the atmosphere, the spark, instead of passing through a mixture of hydrogenous and oxygenous gas, as in our climate, passes through a mixture of oxygenous and azotic gas: it must, therefore, cause a production of nitrous gas, nitrous acid, and nitric acid, which give birth to ruddy vapours, whose red colour will vary according to the quantity and proportion of those different substances which are generated. These vapours are carried towards the south where the air is most dilated, so that they approach more and more towards the spectator; and it is probable their motion may be assisted by a north wind. Sometimes they rise, as if to the zenith of the spectator, and then descend again towards the south: and a great number of causes may carry the vapours towards the different points of the heavens, whence originate the different motions taken by the aurora borealis, or its several parts. Lastly, the detonations which are sometimes heard, depend upon the small quantity of hydrogenous gas, which is found in the upper regions of the atmosphere, and which combines with the oxygen to form water.

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[1] Captain Monk, who wintered on the shore of Hudson's Bay, in the year 1619, relates, that the cold was so intense, that neither *beer*, *wine*, nor *brandy*, could resist it. These were all frozen, and the vessels which contained them were split into pieces; and, before they could use the liquors, they were obliged to hew them with hatchets, and dissolve them by fire. Virgil speaks of *hewing wine*, in his description of a Scythian winter;

Cæduntque securibus humida vina.

These principles, at the same time that they account, in M. Libes's estimation, for all the phenomena accompanying the aurora borealis, explain also why it is so common towards the poles, and so rare in the temperate regions; while thunder, which is frequent in the torrid zone, is scarcely ever heard in the polar regions. The disengagement of hydrogenons gas is considerable near the equator, and very little towards the poles: and when we excite the electric spark in a mixture of hydrogen, oxygen, and azote, it combines, in preference, with the bases of the two former gases: the electric spark ought, therefore, to occasion thunder solely in hot countries, and to produce auroræ boreales in cold countries.

But, to pursue our description, as we advance farther into these dreary regions, we may still meet with those picturesque objects, that can attract and captivate the most incurious eye. In the icy seas, and particularly at Spitzbergen (which is the largest of that group of frozen islands, which go under that name, or that of New Greenland), the forms assumed by the ice are extremely pleasing. The surface of that which is congealed from the sea water (for we must allow it two origins) is flat, even, hard, and opaque, resembling white sugar, and is capable of being slid upon. The greater pieces, or fields, are many leagues in length: the smaller, are the *meadows* of the seals, on which those animals, at times, frolic by hundreds. The motion of the smaller pieces is as rapid as the currents: the greater, which are sometimes two hundred leagues long, and sixty or eighty broad, move slowly and majestically. They often fix, for a time, immoveable by the power of the ocean, and then produce, near the horizon, that bright white appearance, called by mariners the *blink of the ice.* The approximation of two great fields produces a most singular phenomenon: it forces the lesser (if that term can be applied to pieces several acres square) out of the water, and adds them to their surface: a second, and often a third, succeeds; so that the whole forms an aggregate of a tremendous height. These float in the sea like so many rugged mountains, and are sometimes five or six hundred yards thick; but the far greater part is concealed beneath the water. These are continually increased in height by the freezing of the spray of the sea, or of the melting of the snow which falls on them. Those which remain in this frozen climate, receive continual growth: others are gradually wafted by the northern winds into southern latitudes, and melt by degrees, by the heat of the sun, till they waste away, and disappear in the boundless element.

Cowper has some lines on the ice-islands seen floating in the German ocean; we quote a part only of this pleasing description:

> Like burnished brass they shine, or beaten gold;
> And all around the pearl's pure splendour show,
> And all around the ruby's fiery glow.
> Come they from India, where the burning earth,
> All bounteous, gives her richest treasures birth;
> And where the costly gems, that beam around
> The brows of mightiest potentates are found?
> No. Never such a countless, dazzling store
> Had left, unseen, the Ganges' peopled shore.
> Rapacious hands, and ever-watchful eyes,
> Should sooner far have marked and seized the prize.
> Whence sprang they then? Ejected have they come
> From Ves'vius', or from Ætna's burning womb?
> Thus shine they self-illumed, or but display
> The borrowed splendours of a cloudless day?
> With borrowed beams they shine. The gales that breathe
> Now landward, and the current's force beneath,
> Have borne them nearer: and the nearer sight
> Advantaged more, contemplates them aright.
> Their lofty summits crested high, they show,
> With mingled sleet, and long incumbent snow,
> The rest is ice. Far hence, where, most severe,
> Bleak winter well nigh saddens all the year,
> Their infant growth began. He bade arise
> Their uncouth forms, portentous in our eyes.
> Oft, as dissolved by transient suns, the snow
> Left the tall cliff to join the floods below;
> He caught, and curdled with a freezing blast
> The current, ere it reached the boundless waste.

The collision of the great fields of ice, in high latitudes, is often attended with a noise, that, for a time, takes away the power of hearing any thing else; and the meeting of the lesser fields is attended with a grinding of unspeakable horror. The water, which dashes against the mountainous ice, freezes into an infinite variety of forms, and gives the voyager ideal towns, streets, churches, steeples, and every shape which imagination can frame.

The icebergs or glaciers of the north-west of Spitzbergen are among the capital wonders of the country. The glaciers of Switzerland seem contemptible to these. They are seven in number, but at considerable distances from each other; and each fills the vallies for tracts unknown, in a region totally inaccessible in the internal parts. The last exhibits over the sea a front three hundred feet high, emulating the emerald in colour: cataracts of melted snow precipitate down various parts; and black spiring mountains, streaked with white, bound the sides, and rise in the back ground, crag above crag, as far as the eye can reach.

At times, immense fragments break off, and tumble into the water with a most alarming dashing. A piece of this vivid green substance has fallen, grounded in twenty-four fathoms water, and spired above the surface fifty feet. Similar icebergs are common in all the arctic regions; and to their lapses is owing the solid mountainous ice which infests those seas.

Frost sports also with these icebergs, and gives them majestic as well as other most singular forms. Masses have been seen assuming the shape of a Gothic church, with arched windows and doors, and all the rich tracery of that style, composed of what an Arabian tale would scarcely dare to relate, of crystal of the richest sapphirine blue. Tables, with one or more feet, and often immense flat-roofed temples, supported by round transparent columns of cerulean hue, float by the astonished spectator. These icebergs are the creation of ages, and receive, annually, additional heights, by the falling of snow and rain, which often instantly freezes, and more than repairs the loss by the influence of the melting sun.

Such are part of the wonderful phenomena of the polar regions. There are other curious particulars, which, with some reflections suitable to the subject, we shall reserve for our next paper; concluding this with part of Thomson's magnificent description of the icy regions:

The Muse
Thence sweeps the howling margin of the main;
Where undissolving, from the first of time,
Snows swell on snows amazing to the sky;
And icy mountains high on mountains piled,
Seem to the shivering sailor from afar,
Shapeless and white, an atmosphere of clouds.
Projected huge, and horrid, o'er the surge,
Alps frown on Alps; or rushing hideous down,
As if old Chaos was again returned,
Wide-rend the deep, and shake the solid pole.
Ocean itself no longer can resist
The binding fury; but, in all its rage
Of tempest taken by the boundless frost,
Is many a fathom to the bottom chained,
And bid to roar no more: a bleak expanse,
Shagged o'er with wavy rocks, cheerless, and void
Of every life, that from the dreary months
Flies conscious southward. Miserable they!
Who here entangled in the gathering ice,
Take their last look of the descending sun:
While, full of death, and fierce with tenfold frost,
The long, long night incumbent o'er their heads,
Falls horrible. Such was the Briton's [1] fate,
As with *first* prow (what have not Britons dared!)
He for the passage sought, attempted since
So much in vain, and seeming to be shut
By jealous Nature with eternal bars.
In these fell regions, in Arzina caught,
And to the stony deep his idle ship
Immediate sealed, he with his hapless crew,
Each full exerted at his several task,
Froze into statues; to the cordage glued
The sailor, and the pilot to the helm.

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[1] Sir Hugh Willoughby, sent by Queen Elizabeth, to discover the north-east passage.

No. V.

FURTHER REFLECTIONS ON THE POLAR WINTER.

Vast regions dreary, bleak, and bare!
There on an icy mountain's height,
Seen only by the Moon's pale light,
Stern Winter rears his giant form,
His robe a mist, his voice a storm:
His frown the shiv'ring nations fly,
And, hid for half the year, in smoky caverns lie.

JOHN SCOTT.

IN the preceding paper, we described the picturesque appearances of the ice in the dreary regions of Spitzbergen. The snow, moreover, in those high latitudes, exhibits phenomena not less singular than those of the ice. At first, it appears small and hard as the finest sand; it then changes its form to that of a hexagonal shield, into the shape of needles, crosses, cinquefoils, and stars, some plain, and some serrated rays. These forms depend upon the disposition of the atmosphere; and in calm weather, the snow coalesces, and falls in clusters.

The single night of this dreadful country begins about the 30th of October: the Sun then sets, and never appears till about the 10th of February. A glimmering, indeed, continues some weeks after the setting of the Sun: then succeed clouds and thick darkness, broken by the light of the Moon, which is as luminous as in England, and, during this long night, shines with unfailing lustre. The cold strengthens with the new year; and the Sun is ushered in with an unusual severity of frost. By the *middle of March*, the cheerful light grows strong; the arctic foxes leave their holes; and the sea-fowl resort, in great multitudes, to their breeding places. The Sun sets no more after the 14th of May; the distinction of day and night is then lost.

In the height of summer, the Sun has heat enough to melt the tar on the decks of ships; but from August its power declines: it sets fast. After the middle of September, day is hardly distinguishable, and, by the end of October, takes a long farewell of this country: the days now become frozen, and winter reigns triumphant.

Earth and soil are denied to the frozen regions of Spitzbergen: at least, the only thing which resembles soil, is the grit worn from the mountains by the power of the winds, or the attrition of cataracts of melted snow: this, indeed, is assisted by the putrefied lichens of the rocks, and the dung of birds, brought down by the same means. The composition of these islands is stone, formed by the sublime hand of omnipotent Power; not fritted into segments, transverse or perpendicular, but cast, at once, into one immense and solid mass. A mountain, throughout, is but a single stone, destitute of fissures, except in places cracked by the irresistible power of frost, which often causes lapses, attended by a noise like thunder, and scattering over their bases rude and extensive ruins.

The vallies, or rather glens, of this country, are filled with eternal ice or snow. They are totally inaccessible, and known only by the divided course of the mountains, or where they terminate in the icebergs or glaciers we have already described. No streams water their dreary bottoms; and even springs are denied. The mariners are indebted for fresh water solely to the periodical *cataracts* of melted snow in the short season of summer, or to pools in the the middle of the vast fields of ice.

Yet, even here, Flora deigns to make a short visit, and to scatter a scanty stock over the bases of the hills: her efforts never rise beyond a few humble herbs, which shoot, flower, and seed, in the short warmth of June and July, and then wither into rest until the succeeding year. Among these, however, the salubrious scurvy-grass, the resource of distempered frames, is providentially most abundant.

Such, after all, is the aspect of extreme sterility and desolation in these dreary regions, that we can scarcely imagine any mortal would be so hardy as to make them even a temporary abode. Yet here did four Russian mariners, who were accidentally left on this frozen coast in the year 1743, live six years (one excepted), till happily released by the arrival of a ship. In 1633, seven Dutch sailors were voluntarily left here to pass the winter, and to make their remarks; but they all perished from the effects of the scurvy. In the following year, seven more self-devoted victims of the same nation underwent a similar fate; yet all these adventurous men had been liberally provided with medicines, and every necessary for the preservation of life. Eight Englishmen, left by accident in the same country, in 1650, were far more fortunate: unprovided with every thing, they contrived, however, to frame a hut of some old materials, and were found by the returning ships, the next year in perfect health. The Russians have attempted to colonize these dreadful islands. They have annually sent parties to continue there the whole year, who have established settlements at Spitzbergen and other places adjacent, where they have built huts, each of which is occupied by two boats' crews, or twenty-six men.

They bring with them salted fish, rye-flour, and the serum or whey of sour milk. The whey is their chief beverage, and is also used in baking their bread. Each hut has an oven, which serves also as a stove; and their fuel is wood, which they bring with them from Archangel. Their huts are above ground, and surprisingly warm. They boil their fish with water and rye-meal: this is their winter diet. In summer, they live chiefly on fowls, or their eggs. They are dressed in the skins of the bear or the reindeer, with the fur side next their bodies; their bedding, likewise, is formed of the same. The skin of the fox, which is the most valuable, is preserved as an article of commerce. They have also other employment beside the chase, in catching, with nets, the beluga, or white whale. Few of them die from the severity of the cold; but they are often frost-bitten, so as to lose their toes or fingers; for they are so hardy as to hunt in all weathers. They are at liberty to leave the place by the 22d of September, whether they are relieved by a fresh party from Russia, or not. The great exercise they use; their vegetable food; their method of freshening their salt provision, by boiling it in water, and mixing it with flour; their beverage of whey; and their total abstinence from spirituous liquors; are the happy preservatives from the scurvy, which brought all the preceding adventurers, who perished, to their miserable end.

Where the countries have been long inhabited, in all the arctic coasts of Europe, Asia, and America, the natives, with very few variations and exceptions, seem to be a distinct species both in body and mind, and not to be derived from the adjacent nations, or any of their better proportioned neighbours. Their stature is from four to *four feet* and a half; their skins swarthy, and their hair short, black, and coarse. Their eyes are transversely narrow, and the irides black. They have great heads, high cheek-bones, wide mouths, thick lips, broad chests, slender waists, and spindle shanks. From use, they run up rocks like goats, and up trees like squirrels. They are so strong in the arm, that they can draw a bow which a stout Norwegian can hardly bend; yet lazy even to torpidity, when not incited by necessity; and pusillanimous and nervous to a hysterical degree. These are the natives of Finmark and Lapland. The coasts east of Archangel, as far as the river Oby, are inhabited by the Samoeids; a race as short as the Laplanders, but much uglier, and more brutalized; their food being the carcases of horses, or any other animals. They use the rein-deer to draw their sledges, but are not civilized enough to make it a substitute for the cow.

> Hard by these shores, where scarce his freezing stream
> Rolls the wild Oby, live the last of men;
> And half-enlivened by the distant Sun,
> That rears and ripens man as well as plants,
> Here human nature wears its rudest form.
> Deep from the piercing season sunk in caves,
> Here, by dull fires, and with unjoyous cheer,
> They waste the tedious gloom. Immersed in furs,
> Doze the gross race. Nor sprightly jest, nor song,
> Nor tenderness they know; nor aught of life,
> Beyond the kindred bears that stalk without.
> Till morn, at length, her roses drooping all,
> Sheds a long twilight brightening o'er their fields,
> And calls the quivered savage to the chase.
>
> THOMSON.

Such are the inhabitants of the greatest part of the polar regions, and such is the situation, which, to our imaginations, may appear insupportable. With the deepest veneration for the dispensations of divine Providence, a humane mind may sometimes be apt to inquire, why the benevolent Creator should *have* destined such deplorable scenes of desolation to be the abode of millions of human beings, while others are blessed with temperate climates and smiling skies, with inexhaustable harvests and superfluous profusion? But good and evil are often merely relative ideas; and much of what we call happiness on the one hand, and misery on the other, exists less in reality than sentiment. In the Laplanders, for instance, the hardy temperament of their bodies, calculated to resist the rigour of their climate; the 'furry nations' with which their woods abound, and whose skins protect them from the cold; and that peculiar blessing of these regions, the reindeer; are so many evidences, that Divine Goodness has afforded them many valuable compensations for all the disadvantages under which they labour.

They ask no more than simple nature gives;
They love their mountains, and enjoy their storms.
No false desires, no pride-created wants,
Disturb the peaceful current of their time;
And through the restless ever-tortured maze
Of pleasure, or ambition, bid it rage.
There reindeer form their riches. These their tents,
Their robes, their beds, and all their homely wealth
Supply, their wholesome fare, and cheerful cups.
Obsequious at their call, the docile tribe
Yield to the sledge their necks, and whirl them swift
O'er hill and dale, heaped into one expanse
Of marbled snow, as far as eye can sweep,
With a blue crust of ice unbounded glazed.
By dancing meteors then, that ceaseless shake
A waving blaze refracted o'er the heavens,
And vivid moons and stars that keener play
With double lustre from the glossy waste,
Even in the depth of polar night, they find
A wondrous day; enough to light the chase,
Or guide their daring steps to Finland-fairs.
Wished Spring returns; and from the hazy south,
While dim Aurora slowly moves before,
The welcome Sun, just verging up at first,
By small degrees extends the swelling curve!
Till seen, at last for gay rejoicing months,

Still round and round, the spiral course he winds,
And, as he nearly dips his flaming orb,
Wheels up again, and reascends the sky.
In that glad season from the lakes and floods,
Where pure Niemi's [1] fairy mountains rise,
And, fringed with roses [2], Tenglio rolls his stream,
They draw the copious fry. With these at eve,
They cheerful loaded to their tents repair;
Where, all day long in useful cares employed,
Their kind unblemished wives the fire prepare.
Thrice happy race! by poverty secured
From legal plunder and rapacious power:
In whom fell interest never yet has sown
The seeds of vice: whose spotless swains ne'er knew
Injurious deed, nor, blasted by the breath
Of faithless love, their blooming daughters woe.

THOMSON.

A celebrated writer has some observations, which beautifully illustrate this subject. ‘Of the happiness and misery,’ says he, ‘of our present state, part arises from our sensations, and part from our opinions; part is distributed by nature, and part is, in a great measure, apportioned by ourselves. Positive pleasure we cannot always obtain, and positive pain we often cannot remove. No man can give to his own plantations the fragrance of the Indian groves; nor will any precepts of philosophy enable him to withdraw his attention from wounds or diseases. But the negative infelicity, which proceeds not from the pressure of sufferings, but the absence of enjoyments, will always yield to the remedies of reason.

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[1] M. de Maupertuis, in his book on the Figure of the Earth, after having described the beautiful lake and mountain of Niemi in Lapland, says,—‘From this height we had the opportunity, several times, to see those vapours rise from the lake, which the people of the country call Haltios, and which they deem to be the guardian spirits of the mountains. We had been frighted with stories of bears that haunted this place, but saw none. It seemed rather a place of resort for fairies and genii, than bears.’

[2] The same author observes,—‘I was surprized to see upon the banks of this river (the Tenglio) roses of as lively a red as any that are in our gardens.’

'One of the great arts to escape superfluous uneasiness, is to free our minds from the habit of comparing our condition with that of others on whom the blessings of life are more bountifully bestowed, or with imaginary states of delight and security, perhaps unattainable by mortals. Few are placed in a situation so gloomy and distressful, as not to see every day beings more forlorn and miserable, from whom they may learn to rejoice at their own lot.

'No inconvenience is less superable by art or diligence than the inclemency of climates, and therefore none affords more proper exercise for this philosophical abstraction. A native of England, pinched with the frost of December, may lessen his affection for his own country, by suffering his imagination to wander in the vales of Asia, and sport among woods that are always green, and streams that always murmur; but, if he turns his thoughts toward the polar regions, and considers the nations to whom a great portion of the year is darkness, and who are condemned to pass weeks and months amid mountains of snow, he will soon recover his tranquillity; and, while he stirs his fire, or throws his cloak about him, reflect how much he owes to Providence, that he is not placed in Greenland or Siberia.'

These admirable observations not only illustrate the subject, but inculcate lessons, which, if attended to, will much conduce to diminish the pressure, of imaginary evils, and to improve and heighten the happiness we enjoy. Were we condemned to the dreary climes, and to the manner of life, of the natives of the arctic countries, we should deem it insupportable. How deplorable should we think our situations, if we saw nothing before our eyes but stupendous mountains of ice and extensive wastes of snow; if the absence of the Sun, for entire months, rendered the cold more insupportable still; if, instead of our comfortable habitations, we had no other asylum than a gloomy cavern, or a skin-covered tent; if we had no other resource for our subsistence than a perilous activity in the chase; and if we were deprived of all the pleasures which the arts impart, and of all the sweets of society that exalt existence, and render life delightful! Let the consideration, then, of the unspeakable advantages which we enjoy in our temperate clime, and to which we are so inattentive, not only banish every repining thought, that we are not placed in still milder regions and still serener skies, but teach us to regard the Divine Being with increasing love and unceasing adoration. Most sincerely do we accord with the Danish Poet:—

Oh! no where blooms so bright the summer rose,
As where youth cropt it from the valley's breast;
Oh! no where are the downs so soft as those
That pillowed infancy's unbroken rest.

In vain the partial sun on other vales
Pours lib'ral down a more exhaustless ray,
And vermeil fruits, that blush along their dales,
Mock the pale products of our scanty day.

In vain, far distant from the land we love,
The world's green breast soars higher to the sky;
Oh! what were heav'n itself, if lost above
Were the dear memory of departed joy?

Oh! what are Eloisa's bowers of cost,
Matched with the bush, where, hid in berries white,
Mine arms around my infant love were crossed?
What *Jura's* peak, to that upon whose height
I strove to grasp the moon; and where the flight
Of my first thought was in my MAKER lost[1]?

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[1] Poems from the Danish, translated by Mr. Walker, of Cambridge, pp. 75—79, 1815.

In the midst of those dreary scenes, which even 'our infant winter' may sometimes exhibit, let us rejoice in the enchanting prospect of that delightful season, which will so soon awaken all Nature, and diffuse warmth, and life, and happiness around.

Too delicate! reproach no more
The seasons of thy native shore:
There soon shall Spring descend the sky,
With smiling brow and placid eye:
A primrose wreath surrounds her hair;
Her green robe floats upon the air;
And, scattered from her lib'ral hand,
Fair blossoms deck the trees, fair flowers adorn the land.
JOHN SCOTT.

No. VI.

REFLECTIONS ON THE EXISTENCE OF A SUPREME BEING.

There's no philosophy without a God. BLACKMORE.

By steps directing our enraptured search
To Him, the First of Minds; the Chief, the Sole.
AKENSIDE.

THE commencement of a new year[1] must naturally suggest to a wise man some reflections on the years which are now no more, and some anxiety concerning those which are yet to come. If his progress in knowledge and virtue has been in proportion to the opportunities of acquisition, a retrospect of the past must afford the most exquisite satisfaction; and, for the future, he can entertain no other anxiety, than that the years, which, as it were, have been habitually devoted to God, be not lost by the guilt or indiscretion of a moment; but that the same vigilance and circumspection by which he was so long enabled to repel temptation; and the same ardour in the pursuits of excellence, which had hitherto been productive of such happy effects; may, at last, conduct him to that blessed situation, which the Psalmist emphatically describes as his end: '*Mark the perfect man, and behold the upright; for the end of that man is peace.*'

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[1] This paper was first printed in a Magazine, published on the 1st of January.

The firm conviction of a Supreme Being, who is the rewarder of them that diligently seek him, is the actuating principle of such a man, in all the vicissitudes of life. His confidence in the divine protection, his resignation to the divine will, his habitual regard to the divine presence; in a word, those hopes of a happier state, which are the ultimate aim of all his pursuits, may be thus expressed in the beautiful language of Mrs. Barbauld:

If the soft hand of winning pleasure leads,
By living waters, and thro' flowery meads;
When all is smiling, tranquil, and serene,
And vernal beauty paints the flatt'ring scene;
Oh, teach me to elude each latent snare,
And whisper to my sliding heart, Beware!
With caution let me hear the syren's voice,
And doubtful, with a trembling heart, rejoice.
 If friendless, in a vale of tears I stray,
Where briars wound, and thorns perplex my way,
Still let my steady soul thy goodness see,
And with strong confidence lay hold on thee;
With equal joy my various lot receive,
Resigned to die, or resolute to live;
Prepared to kiss the sceptre, or the rod,
While God is seen in all, and all in God.
I read his awful name, emblazoned high
With golden letters on the illumined sky;
Nor less the mystic characters I see
Wrought in each flower, inscribed on ev'ry tree;
In ev'ry leaf that trembles on the breeze
I hear the voice of God among the trees;

With thee in shady solitudes I walk,
With thee in busy crowded cities talk;
In ev'ry creature own thy forming power,
In each event thy providence adore.
Thy hopes shall animate my drooping soul,
Thy precepts guide me, and thy fear control.
Thus shall I rest, unmoved by all alarms,
Secure within the temple of thine arms;
From anxious cares, from gloomy terrors free,
And feel myself omnipotent in thee.
Then, when the last, the closing hour draws nigh,
And earth recedes before my swimming eye;
Teach me to quit this transitory scene
With decent triumph and a look serene;
Teach me to fix my ardent hopes on high,
And, having lived to thee, in thee to die.

But to the bulk of mankind, immersed in the cares of business, or the pursuits of pleasure, this veneration of the Divine Being, this confidence in his goodness, and acquiescence in his dispensations, so far from being habitual, seldom forms the subject of even a momentary meditation; although there is scarcely an object in the creation, how minute and insignificant it may seem, that does not demonstrate the existence of a God,

Who, high in glory, and in might serene,
Sees and moves all, Himself unmoved, unseen.
BROOME.

I shall here lay before my readers a few arguments to prove this important and most essential truth: I say, most essential truth, because, when we are once effectually convinced of this, a due attention to the nature and circumstances of this life, as it respects another, cannot fail to inspire a temper of habitual devotion, and lead us to regard obedience to '*the will of God*' as the great and joyful business of our lives; while every thing else, in these sublunary scenes, will appear, comparatively of no moment. To conduct ourselves with propriety, in whatever situation it shall please divine Providence to place us, we shall consider as being our principal concern; as that which alone can make us truly happy in this life, and solace us with the hopes of immortality.

Nothing can be more evident, than that men, as well as whatever else has life, are weak and dependent creatures, that neither gave existence to themselves, nor can preserve it by any power of their own; and, therefore, we must certainly be indebted for this existence to some superior and more powerful cause. And this superior cause must either be itself the first cause, which is the notion of God, or else, by the same argument as before, must be derived from him, and lead us, consequently, to the knowledge of him. But this argument, which is called the argument *à priori*, with the various deductions from it, is too abstruse for the generality of readers. That admirable metaphysician and divine, Dr. Clarke, in his Demonstration of the Being and Attributes of God, has managed this argument with the greatest perspicuity and force of reasoning, by a series of propositions mutually connected and dependent, and forming a complete and unanswerable argument in proof both of the being and attributes of the Deity.

But there is another argument, called the argument of *à posteriori*, which is more generally obvious, and which carries irresistible conviction. This argument is deduced from the frame of the universe, and the traces of evident contrivance, and fitness of things for each other, that occur through all the parts of it. These conspire to prove, that the material world, which in its nature is originated and dependent, could not have been the effect of chance or necessity, but of intelligence and design. The beautiful, harmonious, and beneficial arrangement of the various bodies which compose the material system; their mutual dependence and subserviency; the regularity of their motions, and the aptitude of these motions for producing the most beneficial effects; and many phenomena resulting from their relation, magnitude, situation, and use; afford unquestionable evidences of the creating power and wise disposal of an intelligent and almighty Agent. The power of gravity, by which the celestial bodies persevere in their revolutions, deserves particular consideration. This power penetrates to the centres of the sun and planets, without any diminution of its virtue, and is extended to immense distances, regularly decreasing, and producing the most sensible and important effects. Its action is proportioned to the quantity of solid matter in bodies, and therefore seems to surpass mere mechanism. But, however various the phenomena which depend on this power, and may be explained by it, no mechanical principles can account for its effects; much less, could it have produced, at the beginning, the regular situation of the orbs, and the present disposition of things. Gravity could not have determined the planets to move, from west to east, in orbits nearly circular, almost in the same plane; nor could this power have projected the comets with all the variety of their directions. If we suppose the matter of the system to be accumulated in the centre by its gravity, no mechanical principles, with the assistance of this power, could separate the huge and unwieldy mass into such parts as the sun and planets; and, after carrying them to their different distances, project them in their several directions, preserving still the quality of action and re-action, or the state of the centre of gravity of the system[1]. Such an exquisite structure of things could arise from the contrivance and powerful influences only of an intelligent, free, and omnipotent Agent. The same powers, therefore, which, at present, govern the material universe, and conduct its various motions, are very different from those which were necessary to have produced it from nothing, or to have disposed it in the admirable form in which it now proceeds.

But I should far exceed the limits of this paper, if confining my observation to the earth, our own habitation, I were to enumerate only the principal traces of design and wisdom, as well as goodness, which are discernible in its figure and constituent parts, in its diurnal and annual motion, in the position of its axis with regard to its orbit, in the benefit which it derives from the light and heat of the sun, and the alternate vicissitude of the seasons; in the atmosphere which surrounds it; and in the different species and varieties of vegetables and animals with which it is replenished. No one can survey the vegetable productions of the earth, so various, beautiful, and useful; nor the gradations of animal life, in such a variety of species, all preserved distinct, and propagated by a settled law; each fitted to its own element, provided with proper food, and with instincts and organs suited to its rank and situation, and especially with the powers of sensation and self-emotion, and all more immediately or remotely subservient to the government and use of man, without admiring the skill and design of the original Founder. But these are more signally manifested in the structure of the human frame, and in the noble powers and capacities of the human mind; more especially in the moral principles and faculties, which are a dis-

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[1] See No. XI. on Gravity.

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stances that have now been rec
of similar instances suggested
recurring to the notice of the cur
mind, contrivance is manifest,
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were not formed for each oth
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perfect beauty should be ever formed by the fortuitous operations of unconscious, inactive particles of matter? As well, nay better, and more easily, might he suppose, that an earthquake might happen to build towns and cities; or the materials carried down by a flood fit themselves up without hands into a regular fleet. For what are towns, cities, or fleets, in comparison of the vast and amazing fabric of the universe! In short, atheism offers such violence to all our faculties, that it seems scarcely credible it should ever really find any footing in human understanding.'

I shall conclude this paper with some observations on the Divine Benevolence, by a celebrated author (Dr. Paley), which admirably illustrate my present subject: 'When God,' says he, 'created the human species, either he wished their happiness, or he wished their misery, or he was indifferent and unconcerned about both.

'If he had wished our misery, he might have made sure of his purpose, by forming our senses to be as many sores and pains to us, as they are now instruments of gratification and enjoyment; or, by placing us amid objects so ill suited to our perceptions, as to have continually offended us, instead of ministering to our refreshment and delight. He might have made, for example, every thing we tasted bitter; every thing we saw loathsome; every thing we touched a sting; every smell a stench; and every sound a discord.

'If he had been indifferent about our happiness or misery, we must impute to our good fortune (as all design, by this supposition, is excluded) both the capacity of our senses to receive pleasure, and the supply of external objects fitted to produce it.

'But either of these, and still more both of them, being too much to be attributed to accident, nothing *remains* but the first supposition, that God, when he created the human species, wished their happiness; and made for them the provision which he has made, with that view, and for that purpose.

'The same argument may be proposed in different terms, thus: Contrivance proves design; and the predominant tendency of the contrivance indicates the disposition of the designer. The world abounds with contrivances; and all the contrivances which we are acquainted with, are directed to beneficial purposes. Evil, no doubt, exists; but is never, that we can perceive, the object of contrivance. Teeth are contrived to eat, not to ache; their aching now and then is incidental to the contrivance, perhaps, inseparable from it: or even, if you will, let it be called a defect in the contrivance; but it is not the object of it. This is a distinction which well deserves to be attended to. In describing implements of husbandry, you would hardly say of a sickle, that it is made to cut the reaper's fingers, though from the construction of the instrument, and the manner of using it, this mischief often happens. But, if you had occasion to describe instruments of torture or execution, this engine, you would say, is to extend the sinews; this to dislocate the joints; this to break the bones; this to scorch the soles of the feet. Here pain and misery are the very objects of the contrivance. Now, nothing of this sort is to be found in the works of nature. We never discover a train of contrivance to bring about an evil purpose. No anatomist ever discovered a system of organization, calculated to produce pain and disease; or, in explaining the parts of the human body, ever said, this is to irritate; this to inflame; this duct is to convey the gravel to the kidneys; this gland to secrete the humour which forms the gout. If by chance he comes at a part of which he knows *not the use, the* most he can say is, that it is useless: no one ever suspects that it is put there to incommode, to annoy, or torment. Since, then, God hath called forth his consummate wisdom to contrive and provide for our happiness, and the world appears to have been constituted with this design at first, so long as this constitution is upholden by him, we must, in reason, suppose the same design to continue.

'There is always a single example, by which each man finds himself more convinced than by all others put together. I seem, for my own part, to see the benevolence of the Deity more clearly in the pleasures of very young children, than in any thing in the world. The pleasures of grown persons may be reckoned partly of their own procuring; especially if there has been any industry, or contrivance, or pursuit, to come at them; or if they are founded, like music, painting, &c. upon any qualification of their own acquiring. But the pleasures of a healthy infant are so manifestly provided for it by another, and the benevolence of the provision is so unquestionable, that every child I see at its sport affords to my mind a kind of sensible evidence of the finger of God, and of the disposition which directs it.'

No. VII.

REFLECTIONS ON THE SOLAR SYSTEM.

Quid potest esse tam apertum, tamque perspicuum, cum cœlum suspeximus, cœlestiaque contemplati sumus, quam esse aliquod Numen præstantissimæ mentis, quo hæc regantur? CICERO.

'*The heavens declare the glory of God, and the firmament showeth forth his handy work.*' DAVID.

WHEN Winter extends his desolate domain, and we are deprived of all the beauties of contemplation in the vegetable world, the radiant orbs on high still shine with undiminished splendour, and inspire the religious philosopher with the most awful sentiments of wonder and devotion. Their prodigious magnitude and distances, with the regularity and harmony of their motions, all concur to declare, with the eloquent heathen philosopher and the royal Psalmist above, that, 'the hand that formed them is divine.'

It is no wonder, then, that astronomy is a science of the earliest antiquity, and that it has claimed the admiration of all ages. Poets, philosophers, and historians, have all bestowed upon it the highest encomiums; and even kings[1] have enriched it with their labours. The poets, in particular, have been lavish in their praises of this subject[1]. Of these, however, I shall be content to select a few only from the magnificent effusions of Young, whose sublime muse was more particularly devoted to nocturnal contemplations.

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[1] Belus, King of Assyria; Atlas, King of Mauritania; and Uratus, King of the country situated on the shore of the Atlantic ocean; are severally recorded, as the persons to whom the world owes this noble science; and among the moderns, Alphonsus, King of Castile, enriched it with those tables that still bear his name.

How is Night's sable mantle laboured o'er,
How richly wrought with attributes divine!
What wisdom shines! what love! This midnight pomp,
This gorgeous arch, with golden worlds inlaid!
Built with divine ambition! nought to Thee;
For others this profusion.

—

The soul of man, His face designed to see,
Who gave these wonders to be seen by man,
Has here a previous scene of objects great
On which to dwell; to stretch to that expanse
Of thought, to rise to that exalted height
Of admiration, to contract that awe,
And give her whole capacities that strength,
Which best may qualify for final joy.

—

This prospect vast, what is it?—Weighed aright,
'Tis nature's system of divinity,
And every student of the night inspires,
'Tis elder scripture writ by God's own hand.

—

What read we here?—The existence of a God?—
Yes, and of other beings, man above;
Natives of either, sons of higher climes?

—

Why from yon arch, that infinite of space,
With infinite of lucid orbs replete,
Which set the living firmament on fire,
At the first glance, in such an overwhelm
Of wonderful, on man's astonished sight
Rushes Omnipotence?

—

Night opes the noblest scenes, and sheds an awe,
Which gives those venerable scenes full weight,
And deep reception in the intendered heart.
This gorgeous apparatus? This display!
This ostentation of creative power!
This theatre!—what eye can take it in?

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[1] Manilius, a Roman poet, wrote a poem on Astronomy of which five books are extant.

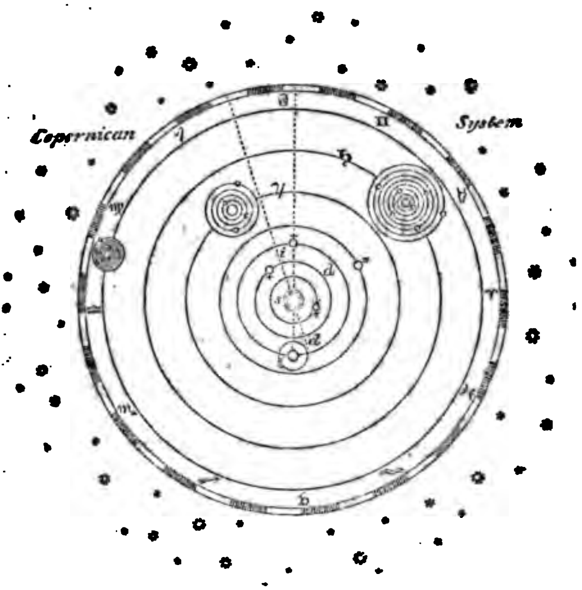
By what divine enchantment was it raised,
For minds of the first magnitude to launch
In endless speculation, and adore?
One sun by day, by night ten thousand shine,
And light us deep into the Deity;
How boundless in magnificence and might?

Bright legions swarm unseen, and sing, unheard
By mortal ear, the glorious Architect,
In this his universal temple, hung
With lustres, with innumerable lights,
That shed religion on the soul; at once,
The temple and the preacher! O how loud
It calls Devotion!—genuine growth of Night!
—Devotion! daughter of Astronomy!
An undevout astronomer is mad.

What magnificent ideas of the Creator and his works, indeed, does the starry firmament present! How far superior the subject to the most sublime conceptions of the human mind!

Astronomy, indeed, derives from its nature a certain degree of dignity, and upon it, we should recollect that navigation (so important to the interests of this country), geography, and chronology, chiefly depend. By the aid of astronomy, man is enabled to pass the apparently boundless ocean, to penetrate into foreign climates, to become better acquainted with those which he inhabits, and regulate the dates of ages past.

The heavens appear to us to be thickly spangled with stars of different magnitudes and degrees of brilliancy: these are called fixed stars and planets. The ancients, who knew so little of the motions of the planets, had no means of investigating the true disposition of their orbits, which is the cause of the variety of opinions formerly held on this subject. Some of their philosophers supposed the earth to be immoveable, as the centre of the universe, and that all the celestial bodies moved round her. *Among these was* Claudius Ptolemy, the ce-



between the orbits of Mars and Jupiter. In our figure, the small circles about the primary planets are made to represent the orbits of their satellites: thus, our Earth has one, the Moon; Jupiter has four; Saturn has seven; and the Georgium Sidus has six.

The Planets, like the Earth, are opaque bodies, and nearly spherical. Being opaque in themselves, they become visible only by reflecting the light which they receive from the Sun. The laws by which they are governed were discovered by Kepler, who demonstrated that they must necessarily revolve in elliptical and not in circular orbits.

Astronomers have divided the planets into two classes: in the first are the *primary* planets, viz. *Mercury*, Venus, the Earth, Mars, Ceres, Pallas, Juno, Vesta, Jupiter, Saturn, and the Georgium Sidus. The second class includes the satellites which belong to some of the primary planets, such is the Moon, attendant upon the Earth; such also are the four moons or satellites that revolve about Jupiter; the seven that revolve about Saturn; and the six that wait on the Georgium Sidus.

The *primary* planets revolve about the Sun, and are divided into the *inferior* and *superior*. The *former* are those whose distance from the Sun is less than that of the Earth, and the latter are those whose distance is greater than that of the Earth. Mercury and Venus are inferior planets, or those whose orbits are included within that of the Earth. Mars, Ceres, Pallas, Juno, Vesta, Jupiter, Saturn, and the Georgium Sidus, are superior planets, all whose orbits are beyond the orbit of the Earth.

The planet Mercury is about 3224 miles in diameter, and revolves around the Sun in 88 days, at the distance of 37 millions of miles. When Mercury is viewed with a telescope of high magnifying power, he exhibits nearly the same phases as the Moon, being sometimes horned, and sometimes full. He is always seen on the same side of the heavens as the Sun; of course, when he is visible in the morning it is in the east, just before Sunrise, and when seen in an evening it is in the west, soon after the setting Sun. It is not known whether he turns on his axis, though Schroeter suspected he had discovered his period to be 24 days, 5 hours, and 28 minutes. The characteristics of this planet are thus described:

> Mercury the first
> Near bordering on the day, with speedy wheel
> Flies swifter on, inflaming where he comes
> With seven-fold *splendour.*

Next, Venus to the westward of the Sun
Full orbed her face, a golden plain of light
Circles her larger round. Fair morning star!
That leads on dawning day to yonder world,
The seat of man.

The diameter of Venus is not quite so large as that of the Earth, it being 7648 English miles in length, and she performs her revolution about the Sun in 224 days, at the distance of 68 millions of miles. With almost any telescope this planet exhibits the same phases as those of the Moon. Venus enjoys rather more than twice the quantity of light and heat experienced by the Earth. She is an evening star when she appears east of the Sun, and a morning star when she is west of him. By Milton she is described as

Fairest of stars, last in the train of night,
If better thou belong not to the dawn,
Sure pledge of day, that crownest the smiling morn[1].

Twice in the course of about 120 years, Venus passes over the disk of the Sun: this phenomenon is called the transit of Venus, and by this, astronomers have been enabled to ascertain, with great accuracy, the distance of the Earth from the Sun. Venus is thought to turn on her axis in 23 hours and 20 minutes, and she is said to have an atmosphere fifty miles in height.

More distant still our globe terraqueous turns,
Nor chills intense, nor fiercely heated burns;
Around her rolls the lunar orb of light,
Trailing her silver glories through the night.
CHATTERTON.

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[1] Fair Venus shines
Even in the eye of day; with sweetest beam
Propitious shines, and shakes a trembling flood
Of softened radiance from her dewy locks.
BARBAULD.

The Earth, of which the foregoing lines are descriptive, turns on its axis in rather less than 24 hours, and thereby causes the succession of day and night. It has likewise another motion by which its annual journey round the Sun is made in 365 days, 5 hours, 48 minutes, 49 seconds. The diameter of the Earth, in its course round the Sun, is not perpendicular to its orbit, but inclined to it in an angle of 23° ½, and it is owing to this that the days are of different lengths in different parts of the globe. And the varying seasons of spring, summer, autumn, and winter, depend, 1. On the length of the days and nights; and, 2. Upon the position of the Earth with respect to the Sun, that is, upon the perpendicularity with which the rays of the Sun fall upon any particular part of the Earth.

The Earth's diameter is nearly 8000 miles long, so that any point on its equator is perpetually moving, by the diurnal motion only, at the rate of 1000 miles an hour. Its motion, in its annual journey round the Sun, is about 65,000 miles in an hour; but the motion of Mercury, in his orbit, is at the rate of 105,000 miles in an hour.

Between the orbit of the Earth, and that of Mars, which has generally been reckoned the *first* of the superior planets, there have been discovered, in the course of the present century, *four* very small planetary bodies, sometimes called *Asteroids.*

The first of these was discovered on the 1st of January 1801, by M. Piazzi, of Palermo: its mean distance from the Sun is not quite three times that of the Earth: its revolution is performed in four years, seven months, and ten days; and its orbit is inclined to the ecliptic, in an angle of about 10 ½ degrees; which is considerably greater than that *of any of the planets* formerly known. This planet is much less in size than our Moon, and is distinguished by the name *Ceres*.

The second was discovered on the 20th of March 1802, by Dr. Olbers, of Bremen: its distance from the Sun, time of revolution, and magnitude, are nearly the same as those of Ceres; and the orbits of the two intersect each other: though that of this planet is inclined to the ecliptic, in an angle of 34½ degrees. It is called *Pallas*.

The third was discovered on the 1st of September 1804, by M. Harding, of Lilienthal: its mean distance from the Sun is rather greater than that of the two former; and its size nearly equal to that of Ceres. Its inclination is 21 degrees; and it appears like a star of the 8th magnitude. Harding has given to this planet the name of *Juno*.

The fourth was discovered by Olbers, early in 1807: it is nearer to Mars than either of the other newly discovered planets: and the revolution through its orbit is performed in 1136 of our days. The inclination of the orbit to the ecliptic is 7 and 1-7th degrees, being rather more than that of Mercury. Astronomers have given to this planet the name of *Vesta*.

Mars, the first of the superior planets, is distinguishable from the rest by the red and fiery appearance of his disk, which is attributed to the density of his atmosphere:

> Beyond our globe the sanguine Mars displays
> A strong reflection of primeval rays.

His figure, like that of the Earth, is an oblate spheroid. He travels round the Sun in about 687 of our days, at the mean distance of 144 millions of miles from that body; and, therefore, he travels in his orbit at the rate of 53,000 miles in an hour. He has likewise a rotation on his axis in 24 hours

39 minutes, which was discovered by means of an immensely large spot seen on his surface, when he is in that part of his orbit which is opposite to the Sun and Earth.

> Beyond the sphere of Mars, in distant skies
> Revolves the mighty magnitude of Jove,
> With kingly state, the rival of the Sun.
> About him round, four planetary moons,
> On Earth, with wonder all night long beheld,
> Moon above Moon, his fair attendants dance.

Such is Mallet's description of the planet Jupiter, the largest of all the planetary bodies, and, next to Venus, the brightest. When viewed through a good telescope, several belts, or bands, darker than the general surface, are observed across the disk parallel to his equator, which, as they are constantly varying, are supposed to be a series of clouds in his atmosphere. Spots have been occasionally discovered on his disk between the belts; and, from their disappearance and reappearance, his rotation has been estimated at about 9 h. 55 m. 37 s. of our time. This planet is 89,170 miles in diameter, or about 11 times larger than our Earth; of course, as his apparent disk increases according to the square of his diameter, our Earth will, to the inhabitants of Jupiter, appear 121 times less than this noble planet appears to us. Jupiter is more than twelve hundred times larger than the Earth. He performs his annual journey round the Sun, at the distance of 493 millions of miles from that luminary, in something less than 12 of our years.

His form, like that of the earth and Mars, is that of an oblate spheroid, but, owing to the velocity of his diurnal motion, his equatorial diameter is 6000 miles longer than his polar one. Jupiter, being five times farther distant from the Sun than *the Earth, enjoys only* a twenty-fifth part as much light and heat as we experience: and, as he moves in his orbit with his axis perpendicular to the plane of that orbit, the inhabitants will experience no change of seasons, nor difference in the length of their days and nights. These will be always nearly five hours each; and at the equator of Jupiter, there must be perpetual summer, and at the poles an unceasing winter.

The planet Saturn is more than 79,000 miles in diameter, and is distinguished, when observed by the naked eye, by its pale light, very unlike that of Jupiter and the other planets: from these also he is distinguished by a large luminous ring, surrounding his body, which was discovered by the celebrated Huygens: he is compared, as to his distance from the centre and other properties, by Chatterton,

> But farther yet the tardy Saturn lags,
> And seven attendant luminaries drags,
> Investing with a double ring his pace,
> He circles thro' immensity of space.

His distance from the Sun being so great, his motion in his orbit is proportionally slow; and his journey being so much longer likewise than that of the other planets, he takes almost 30 of our years to accomplish one of his; nevertheless, he travels at the rate of more than 20,000 miles in an hour, and yet the poet, comparing his motion with that of the other planets, calls it a tardy and lagging motion. His distance from the Sun being between 9 and 10 times greater than that of the Earth, he will enjoy only about the nineteenth part of the light and heat experienced by us; the light, however, which is spread upon this remote planet, is computed to be equal to that which 500 of our full Moons would exhibit to us, and, therefore, it is only by comparison that our accomplished poetess, Mrs. Barbauld, speaks of his situation as

> The dim verge, the suburbs of the system
> Where cheerless Saturn, midst his watery moons,
> Girt with a lucid zone, majestic sits.

When Saturn is examined by a good telescope, he appears to be of a spheroidal form, which arises from the rapid rotation of the planet upon his axis, which Dr. Herschel has found to be performed in little more than ten hours. The surface of Saturn is diversified, like that of some of the other planets, with dark spots and belts. Huygens observed five belts which were nearly parallel to the equator. They were noticed likewise by Cassini and Messier. Dr. Herschel has likewise observed several belts which in general are parallel with the ring. On the 11th of November, 1793, he noticed a bright, uniform, and broad belt, and close to it a broad and darker belt, divided by two narrow white streaks; so that he evidently saw five belts, three of these were dark and two bright. These belts cover a larger zone of the disk of Saturn, than the belts of Jupiter occupy upon his surface.

The ring of Saturn, which makes a most beautiful appearance through a telescope, consists of two concentric rings, detached from each other, and from the body of the planet, the innermost of which is nearly thrice as broad as the outermost.

The ring of Saturn casts a deep shadow upon the planet. It is sharply defined both in its inner and outer edge, and appears to be more luminous than Saturn himself. Hence it has been inferred that it is not a shining fluid or aurora borealis, but a solid body equal in density to the planet. To this ring the poet refers, when, after speaking of the dreariness of the remote situation of the planet, and of the intensity of the cold, he says,

> Yet even here the sight,
> Amid these doleful scenes, new matter finds
> Of wonder and delight! a mighty ring,
> On each side rising from the horizon's verge,
> Self-poised in air, with its bright circle round
> Encompasseth his orb. MALLET.

The planet Saturn is surrounded with no fewer than seven satellites, which supply him with light during the absence of the Sun; but of these we shall speak hereafter.

The Georgium Sidus, called also the Herschel planet, is, as far as has been discovered, the outermost body of our system. It is too far distant from the earth to admit of very accurate observation, though it has sometimes been seen by the naked eye. The lines which Mallet applied to Saturn are now, with a little change, more applicable to the Georgium Sidus or Herschel planet.

> Last, outmost Herschel walks his frontier round,
> The boundary of worlds; with his pale moons,
> Faint-glimmering thro' the darkness night has thrown,
> Deep dyed and dead, o'er this chill globe forlorn:
> An endless desart, where extreme of cold
> Eternal sits, as in his native seat,
> On wintry hills of never-thawing ice;
> Such Herschel's earth.

This new planet is denominated by foreign astronomers the Uranus, as well as the Herschel. Though discovered by Dr. Herschel, as a planet, it had been observed by Flamstead, Mayer, and others, and put down in their catalogues of fixed stars. It is situated at the distance of 1,800,000 miles from the sun, and performs its annual journey round that luminary in little more than 83 of our years. Its diameter is 35,112 miles, or about 4½ times larger than that of the earth; of course the disk of our planet being 20 times less to the inhabitants of the Herschel than he is to us, it must be wholly invisible to them without the aid of very powerful glasses. How mortifying to the pride of man, that the planet upon which he lives is so insignificant as not even to be known to exist by other inhabitants of the system of which it is a part!

When seen by the naked eye, it appears like a fixed star of the sixth magnitude, with a blueish white light, and a brilliancy between that of Venus and the moon.

Besides the primary planets here mentioned, there are eighteen others, called secondary planets, or satellites, which regard their primaries as the centres of their motions, and revolve round them in the same manner as those primaries do round the sun.

One of the most conspicuous of these satellites is the moon, which is a constant attendant on the earth; and, while she accompanies it in its annual progress through the heavens, keeps revolving round it continually, by a different motion, in the space of a month. The diameter of the moon is 2180, her distance from the earth 240,000 miles; and in bulk she is sixty times less than the earth. Jupiter has four such moons, Saturn seven, and the Georgian six: and from the continual change of their phases or appearances, it is evident that these also are opaque bodies, like the planets, and shine only by the means of the borrowed light which they receive from the sun.

It may be observed, also, that our earth is a moon to the moon, waxing and waning in exactly the same manner, but appearing about thirteen times larger, and, of course, affording a proportional quantity of light. When she changes on us, the earth will appear full to her; and when she is in her first quarter to us, the earth will be in its third quarter to her. And as her axis is almost perpendicular to the plane of the ecliptic, one half of her orb will be constantly illuminated by the reflected light afforded by the earth in the sun's absence, and the other will have a fortnight's light, and a fortnight's darkness alternately.— The rotation of the moon round the earth is also performed exactly in the same time that she goes once round the earth, as is evident from her always presenting the same face to us during the whole of her monthly revolution; and, on this account, it is plain, that the inhabitants of one half of the lunar world are totally deprived of a sight of the earth, and must for ever remain ignorant of its existence, unless business or pleasure lead them to explore the opposite hemisphere; where they may have a full view of our globe, moving majestically through the heavens, and appearing to them like a newly-created planet, of a magnitude nearly thirteen times larger than that of the sun[1].

Comets are now the only objects in our system that remain to be mentioned; but the consideration of these, and of the infinity of stars that cover the whole face of the heavens, I reserve for my succeeding paper, and conclude this in the beautiful language of Thomson:

With what an awful world-revolving power
Were first the unwieldy planets launched along
The illimitable void! There to remain,
Amid the flux of many thousand years,
That oft have swept the toiling race of men,

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[1] See various other particulars concerning the moon in No. XXII. For a full account of the Solar System, with the recent discoveries of Dr. Herschel, we refer to *Time's Telescope* for 1814, and also to the subsequent volumes for 1815, 1816, and 1817, for a History of Astronomy, and other interesting matter on this subject.

And all their laboured monuments away.
Firm, unremitting, matchless in their course,
To the kind tempered change of night and day,
And of the seasons ever stealing round,
Minutely faithful: such the All-perfect Hand,
That poised, impels, and rules the steady whole.

No. VIII.

ON COMETS.

Hast thou ne'er seen the comet's flaming flight?
Th' illustrious stranger passing, terror sheds
On gazing nations, from his fiery train
Of length enormous; takes his ample round
Through depths of ether; coasts unnumbered worlds
Of more than solar glory; doubles wide
Heaven's mighty cape, and then revisits earth,
From the long travel of a thousand years. YOUNG.

THE astronomy of comets may be properly said to be yet in its infancy, no advances having been made in it before the seventeenth century. With respect to the antients, they knew very little of their nature or motions. Some considered them as wandering stars; others supposed them to be mere appearances, formed either by reflections or refractions of the Sun's beams, having no real or distinct substance from other celestial bodies. Others believed them to be fiery meteors, generated of bituminous exhalations from our terraqueous globe, which, being elevated to the higher regions of the atmosphere, were there set on fire, and continued their appearance till all their sulphureous particles were consumed; while others considered them only as ominous phenomena, displayed by the

Supreme Being to terrify mankind, and warn them of the approach of some dreadful calamity. And the same opinion prevailed during the dark ages between the decline of the Roman empire and the Reformation.

The poets have frequently compared a hero in his shining armour to a comet; and as poetry delights in omens, prodigies, and such wonderful events as were supposed to follow upon the appearance of comets, eclipses, and the like, they never fail to make some allusion to the popular superstition on this subject. Thus Homer, Virgil, and Tasso, who have been copied by Milton, in his fine comparison of Satan to a comet:

> Incensed with indignation, Satan stood
> Unterrified, and like a comet burned,
> That fires the length of Ophiucus huge
> In the arctic sky, and from his horrid hair
> Shakes pestilence and war.

Milton has here exceeded his originals in sublimity; and his comparison is applied with much greater propriety than theirs; for they describe only a mortal hero, but Milton is speaking of a superhuman being.—I shall give two more quotations, in which, I think, the popular opinion is not only poetically but philosophically mentioned:

> In fancy's eye encount'ring armies glare,
> And sanguine ensigns wave unfurled in air[1]!
> Hence the deep vulgar deem impending fate,
> A monarch ruined or unpeopled state.
> Thus comets, dreadful visitants! arise,
> To them wild omens, science to the *wise!*
> *These* mark the comet to the Sun incline,
> While deep-red flames around its centre shine!
> While its fierce rear a winding trail displays,
> And lights all ether with the sweeping blaze!

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[1] The aurora borealis: for an account of the remarkable appearances of this meteor, see No. LI.

Or when, compelled, it flies the torrid zone,
And shoots by worlds unnumbered and unknown;
By worlds, whose people, all aghast with fear,
May view that minister of vengeance near!
Till now, the transient glow, remote and lost,
Decays, and darkens 'mid involving frost!
Or when it, sunward, drinks rich beams again,
And burns imperious on th' ethereal plain,
The learned-one, curious, eyes it from afar,
Sparkling through night, a new illustrious star!

SAVAGE.

Amid the radiant orbs,
That more than deck, that animate the sky,
The life-infusing suns of other worlds;
Lo! from the dread immensity of space
Returning with accelerated course,
The rushing comet to the sun descends;
And as he sinks below the shaded earth,
With awful train projected o'er the heavens,
The guilty nations tremble. But, above
Those superstitious horrors that enslave
The fond sequacious herd, to mystic faith
And blind amazement prone, th' enlightened few
Whose godlike minds philosophy exalts,
The glorious stranger hail. They feel a joy
Divinely great; they in their powers exult,
That wondrous force of thought, that, mounting, spurns
This dusky spot, and measures all the sky;
While, from his far excursion through the wilds
Of barren ether, faithful to his time,
They see the blazing wonder rise anew,
In seeming terror clad, but kindly bent
To work the will of All-sustaining Love:
From his huge vapoury train, perhaps, to shake
Reviving moisture on the numerous orbs,
Through which his long ellipsis winds; perhaps,
To lend new fuel to declining suns,
To light up worlds, and feed th' eternal fire.

THOMSON.

When the terrors, which superstition and astrology formerly excited, had fled before the dawn of philosophy; when Newton, unfolding the system of the universe, had described the laws by which the motions of comets are directed, and Halley had carried the theory of his illustrious predecessor to a high degree of certitude and perfection, their discoveries gave rise to a new kind of anxiety and apprehension. It was feared, that some of the comets, which move in all directions through the different regions of our planetary system, might, some time or other, meet with our earth in its course; and it was supposed that some rencounters may have already happened, and produced the revolutions of which the vestiges are to be found in several parts of our globe. Thus, Whiston considered the general flood as an inundation produced by the tail of a comet, and supposed that the universal conflagration will be occasioned by the earth's meeting with one of those bodies on its return from the Sun. Maupertuis imagined, that the tails of comets, by mixing their exhalations with our atmosphere, might have a noxious influence upon the health of animals and the growth of plants: he farther apprehended, that their attraction might, some time or other, oblige our globe to change its orbit, and to revolve about one of them in the character of a satellite, or, at least, expose it to more violent vicissitudes of heat and cold than it experiences at present. But these terrors are merely visionary, and have been refuted in an essay on this subject, by M. Dionis du Sejour. This work[1], which contains the best theory of comets hitherto published, has the double merit of having given new degrees of perfection and improvement to the science of astronomy, and of calming the fears and apprehensions of mankind, by showing, that we have absolutely little or nothing to fear from those flaming bodies, which ignorance and superstition have rendered so terrible.

Comets, according to Sir Isaac Newton, are compact, solid, fixed and durable bodies: in one word, a kind of planets; which move in very oblique and eccentric elliptical orbits, every way with the greatest freedom; persevering in their motions, even against the course and direction of the planets: and their tail is a very thin slender vapour emitted by the head or nucleus of the comet, ignited or heated by the sun.

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[1] *Essai* sur les Comets en général, &c. Paris, 1775.

From the lights which this great philosopher has thrown upon this abstruse part of astronomy, there is reason to hope that succeeding astronomers will carry it to the greatest degree of perfection. But, although we are indebted to him for a true theory of the *motion* of the comets, yet, with respect to the formation of their *tails*, and the *uses* for which these great bodies are intended, his opinions have been controverted. Dr. Hamilton, in particular, in his Philosophical Essays, controverts Sir Isaac's opinion. He asserts, from a view of the phenomena of a comet, that the matter which constitutes its tail is not an illuminated vapour, but a *self-shining substance*, which, in all positions of the comet, and whatever be the direction of its motion, whether toward or from the sun, is thrown off from its dark hemisphere, in a direction opposite to the sun, a short time before and after its perihelion, or nearest approach to that luminary. He finds, moreover, in the aurora borealis, a matter which greatly resembles it in appearance, its situation with regard to the sun and to the body whence it flows, as well as in the nature of its substance, so far as it is known to us: for the aurora borealis is likewise a rare and lucid substance, thrown off in a direction nearly opposite to the sun, from the dark hemisphere of the earth; tending toward the zenith of the spectator, or the *vertex* of the earth's shadow; rising principally *from the northern* part of the earth's atmosphere, and most frequently visible while the sun is passing through the southern signs, and the earth moving from the autumnal to the vernal equinox, through that half of its orbit which is nearest to the sun; and, lastly, not intercepting, in any sensible degree, the light of the fixed stars: so that, to a spectator placed at a considerable distance from the earth, and shaded from the sun's light, it must appear as a tail to the earth; small, indeed, in proportion to the earth's diameter, but in its direction, situation, transpaparency, and lucid appearance, resembling that of a comet.

Abbé Mann, a learned Englishman, long resident at Brussels, has likewise shown, by unanswerable arguments, that there is a manifest and perfect analogy between the tails of these great and luminous bodies and the aurora borealis; hence he concludes, that they both proceed from the same principle, and are formed of the same matter; that they are emanations of the electrical fluid from their respective bodies, and that this fluid often becomes a phlogiston, by the heterogeneous mixture which it carries along with it in this emanation, which accounts for the different colours and other circumstances in these meteors. 'As electrics (says the Abbé), when sufficiently heated, become conductors of the electrical fluid, and yield emanations of it in proportion to the quantity they naturally contain, this is precisely the case with the earth and the comets in their perihelia. The approach of the comets to the sun, and the superabundant degree of heat which they receive from this approach, dispose them to send forth a proportionable part of the electrical fluid, whose emission produces all the phenomena we observe in the tails of the comets, the auroræ *boreales,* and several electrical experiments; these phenomena, therefore, have the same cause, and one common principle. In the recess of the comet and its increasing distance from the sun, this visible emission of electrical matter diminishes gradually, and, at last, totally disappears; and instead of being an electrical conductor, which it was in its perihelion, it attracts the fluid, is charged with it anew, and thus becomes electric until its approach to the sun, and the heat it acquires thereby, change it again into a conductor[1].

From the prodigious activity of the electrical fluid, its tendency to escape from the bodies which contain it, and to diffuse itself in the vast planetary regions, which come the nearest to void space, the ingenious Abbé draws some conjectures relative to the uses and the end which comets may serve in the planetary system. He thinks that comets are real electrical bodies designed to collect the electrical fluid, which has escaped from the planets: that the comets, heated by their approximation to the sun, communicate this fluid anew to the planets; and thus the perpetual circulation of this active fluid, so necessary to the great *whole*, is maintained and renewed incessantly; and that the operations of nature in the planetary system are carried on in a manner analogous to what we constantly observe and experience in the perpetual circulations of our atmosphere, where winds, vapours, and exhalations, rise and float; then return to us in rain, snow, and fulminating explosions; and then, again, are exhaled and raised anew. 'Every thing (he judiciously observes) is analogous and harmonical in universal nature.'

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[1] Memoir concerning Electrical Fire, &c. in Memoirs of the Academy at Brussels, vol. ii. Many other speculations on the nature of comets are given in Dr. O. Gregory's Astronomy, and in M. Lambert's Letter on Cosmogony. See also Time's Telescope for 1814, p. 317.

I shall conclude this paper with the moral reflections of an elegant writer: 'I cannot forbear reflecting on the insignificance of human art, when set in comparison with the designs of Providence. In the pursuit of this thought, I considered a comet, or, in the language of the vulgar, a blazing star, as a sky-rocket discharged by a hand that is Almighty. Many of my readers saw that in the year 1680; and, if they are not mathematicians, will be amazed to hear, that it travelled with a much greater degree of swiftness than a cannon-ball, and drew after it a tail of fire that was four-score millions of miles in length. What an amazing thought is it to consider this stupendous body traversing the immensity of the creation with such a rapidity, and, at the same time, wheeling about in that line which the Almighty had prescribed for it! That it should move in such inconceivable fury and combustion, and, at the same time, with such an exact regularity! How spacious must the universe be, that gives such bodies as these their full play, without suffering the least disorder or confusion by it! What a glorious show are those beings entertained with, that can look into this great theatre of nature, and see myriads of such tremendous objects wandering through those immeasureable depths of ether, and running their appointed courses! Our eyes may, hereafter, be strong enough to command this magnificent prospect, and our understandings able to find out the several uses of these great parts of the universe. In the mean time, they are very proper objects for our imagination to contemplate, that we may form more extensive notions of Infinite Wisdom and Power, and learn to think humbly of ourselves, and of all the little works of human invention[1].'

There are three comets which have been much celebrated; viz. that which appeared in 1680, just mentioned, and those of 1744 and 1759. The comet of 1680 was remarkable for its near approach to the sun; so near, that in its perihelion it was not above a third part of the diameter of that luminary from the surface thereof. Its great heat in that position was computed to be 2000 times hotter than iron at its white heat; of course, it must have been entirely dissipated, if it had been any other than a fixed and solid body. It must also have retained its heat an immense time; for a globe of iron, of an inch in diameter, exposed to the open air, scarcely loses its heat in less than an hour; but a larger globe will retain its heat longer in proportion to its diameter, because the surface at which it grows cold varies in that proportion less than the quantity of hot matter. Therefore, a globe of red hot iron, as big as our earth, would scarcely cool in 50,000 years. The period of this comet has been calculated at 575 years; and, if the computation be accurate, it will no return to the vicinity of the earth till about the year 2225. This comet, at its greatest distance, is about eleven thousand two hundred millions of miles from the sun, and at its least distance is not more than 49,000 miles. In that part of its orbit which was nearest the sun, it was computed to move at the rate of 880,000 miles in an hour.

Dr. Halley, who saw the comet which appeared in 1682, says, ' that there are many things which make me believe, that the comet which Apian saw in the year 1531, was the same with that which

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[1] Guardian, No. 103.

Kepler and Longimontanus more accurately described in the year 1607, and which I myself have seen return, and observed in 1682. All the elements agree, and nothing seems to contradict this opinion, except the inequality of the periodic revolutions; which inequality is not so great, but that it may be owing to physical causes. For the motion of Saturn is so disturbed by the rest of the planets, especially Jupiter, that the periodic time of that planet is uncertain for some whole days together. How much more, therefore, will a comet be subject to like errors, which rises, perhaps, four times higher than Saturn, and whose velocity, though increased but very little, would be sufficient to change its orbit from an ellipse to a parabola! And I am the more confirmed in my opinion of its being the same; for in the year 1456, in the summer time, a comet was seen passing retrograde between the earth and the sun, much after the same manner; which, though nobody made observations upon it, yet, from its period and manner of transit, I cannot think different from those I have just mentioned; and since looking over the history of comets, I find, at an equal interval of time, a comet to have been seen about Easter in the year 1305, which is another double period of 151 years before the former. Hence, I think, I may venture to foretel that it will return again in 1758.'

Dr. Halley computed the effect of Jupiter upon this comet in 1682, and found that it would increase its periodic time above a year; in consequence of which, he predicted its return at the end of the year 1758, or the beginning of 1759. M. Clairault computed the effects of both Saturn and Jupiter, and found that the former would retard its return in the last period 100 days, and the latter *511 days*; and he determined the time when the comet would come to its perihelion to be on the 15th of April 1759; observing, however, that he might err a month, from neglecting small quantities in the computation. The comet did pass the perihelion on the 13th of March, within 33 days of the time computed. Now, if Dr. Halley meant the time of its passing the perihelion, and we add 100 days for the action of Saturn, which he did not take into the calculation, it will bring it very near to the time in which it passed the perihelion, and prove his computation of the effect of Jupiter to have been accurate. But, if he meant the time when the comet would first appear, his prediction was accurate; for it was first seen on December 14, 1758. Dr. Halley, therefore, had the glory first to foretel the return of a comet; and the event answered, in a remarkable manner his prediction. He further observed, that the action of Jupiter, in the descent of the comet towards its perihelion in 1682, would tend to increase the inclination of its orbit; and, accordingly, the inclination in 1682 was found to be greater by 22 than it was in 1607.

Dr. Halley suspected that the comet in 1680 was the same that appeared in 1106, 531, and also in 44 before the Christian æra. He also conjectured, that the comet observed by Apian in 1532, was the same as that observed by Hevelius in 1661; if so, its period was 129 years, and it ought to have returned in 1789; but it did not appear, though astronomers here, and on the Continent, were watching its approach with great anxiety.

From the beginning of our æra to this time, it is probable, according to the best accounts, that there have appeared 500 comets. Before that time, above 100 others are mentioned in history; but, perhaps, half of *these,* had they been accurately observed, would not have proved comets. When, however, we consider that many others may not have appeared, from being too near the sun; from appearing in moon light; from being in the other hemisphere; from being too small to be perceived; or which may not have been recorded; it is reasonable to suppose that the whole number is much greater. It is, on the other hand, very likely, that of the comets that have been recorded as seen, the same may have appeared several times, and therefore the number may be less than is stated[1].

Very remarkable comets appeared in the year 1807, 1808, and 1811, but as the nature and limits of this work forbid us from entering into a detailed description of them, we shall merely observe, (1) That of the 98 comets whose elements have been observed and calculated previously to the year 1808, 24 have passed between the Sun and the orbit of Mercury; 33 between the orbits of Mercury and Venus; 21 between the orbits of Venus and the Earth; 16 between the orbits of the Earth and Mars; 3 between the orbits of Mars and Ceres; and 1 between those of Ceres and Jupiter. (2) That 32 comets have appeared between the months of April and September, and 66 between September and April. (3) That the greater part of the comets have their perihelion nearest to their ascending nodes. (4) That 50 comets move from west to east. (5) That the orbits of the comets are not confined to any particular region of the heavens, like the planets that have long been known, but seem to be inclined at every possible angle of the ecliptic[2].

[1] See Vince's Complete Sytem of Astronomy.

[2] See Brewster's Ferguson.

No. IX[1].

ON A PLURALITY OF WORLDS.

Nor to this evanescent speck of earth
Poorly confined, the radiant tracts on high
Are *our* exalted range: intent to gaze
Creation through; and, from that full complex
Of never-ceasing wonders, to conceive
Of the Sole Being right, who spoke the word
And Nature moved complete.

* * * * * * *

Oh Nature! all sufficient! over all!
Enrich me with the knowledge of thy works!
Snatch me to heav'n; and show thy wonders there,
World beyond world, in infinite extent,
Profusely scattered o'er the blue immense.

THOMSON.

IN the view I have taken of the planetary system, in my two preceding papers, what a magnificent idea of the Creator, and of his works, is presented to the imagination! In the centre of the system, is placed the SUN, around whose orb, the planets, satellites, and comets, perform their revolutions with a regularity, which must fill the mind with the most exalted conceptions of their Divine Original. Who can contemplate the magnitudes and distances of those vast bodies, and the beautiful harmony of their motions, and not be struck with the grandeur of the scene, and the wonders of Omnipotence? But what must be our astonishment, when we are told that this glorious system is only a small part of the universe; and that, if it were wholly annihilated, it would be no more missed, by an eye that could take in the whole creation, than a grain of sand from the sea shore.

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[1] See also No. XLIII. on the Sun.

To form some idea, however imperfect, of the extent of the universe, and the more glorious works of creation, we must turn our attention to the starry firmament; we must visit those numerous and splendid orbs, which are dispersed throughout the heavens, far beyond the limits of our planetary system.

It is in these higher regions, that the Almighty has displayed himself in such indelible characters, as must rouse the most insensible spectator, and fill his mind with admiration and astonishment. By contemplating the magnitudes and distances of the fixed stars, all partial considerations of high and low, great and small, vanish from the mind; and we are presented with such an unbounded view of Nature, and the immensity of the works of creation, as overpowers all our faculties, and makes us ready to exclaim with the Psalmist, '*Lord, what is man, that thou art mindful of him, or the son of man, that thou regardest him?*'

The fixed stars are distinguished from the planets by being brighter and more luminous, and by continually exhibiting that appearance, which we call the scintillation, or twinkling of the stars. This, probably, arises from their appearing so extremely small, that the interposition of any very minute substance, of which there are many constantly floating in the atmosphere, deprives us of the sight of them: but as the interposed body soon changes its place, we again see the star; and, this succession being perpetual, occasions the twinkling.

But a more remarkable property of the fixed stars, and that from which they obtain their name, is their never changing their situation with regard to each other, as the planets do; for although the revolution of the earth upon its axis occasions an apparent daily motion of the whole frame of the heavens, in a contrary direction, yet any two fixed stars being observed, at several distant intervals of time, will always be found to preserve the same relative position during the whole of this revolution.

It is not to be imagined that the stars are placed in one concave surface, so as to be all equally distant from us; but they are dispersed through unlimited space in such a manner, that there may be as great a distance between any two neighbouring stars, as there is between our sun and those which are the nearest to him; so that an observer, if placed near any fixed star, would consider that alone as a real sun, and the rest as so many shining points, placed at infinite distances from him in the firmament.

Those stars are supposed to be the nearest to us which seem the largest, and are called stars of the first magnitude; and so on as far as the sixth, which includes all the stars that are visible without a telescope. And though, in a clear winter's night, when the moon is below the horizon, the stars seem to be innumerable, yet, as the whole firmament is divided into constellations, the number which can be seen at once, by the naked eye, is not above a thousand.

Since the invention of the telescope, indeed, the number of the stars has been considered as immense; because, the more perfect our instruments are, the more stars appear: it is therefore probable, that no limits can be set to their number or distances.

The immense distance of the fixed stars from each other, and from our earth, is, of all considerations, *the most proper* for exalting our ideas of the works of God, and the extent of the creation. The star nearest to us, or the largest in appearance, is Sirius, or the Dog Star. Now, the earth, in moving round the sun, is 195,000,000 miles nearer to this star in one part of its orbit, than in the opposite one; and yet the magnitude of the star appears not to be in the least altered or affected by it. The celebrated Huygens carried his thoughts so far upon this subject, as to believe that there might be stars at such inconceivable distances from our earth, that their light, though it is known to travel at the rate of 10,000,000 miles in a minute, has not yet reached us since the creation of the world!

How distant some of the nocturnal suns!
So distant says the sage, 'twere not absurd
To doubt, if beams, set out at Nature's birth,
Are yet arrived at this sò foreign world;
Though nothing half so rapid as their flight.
An eye of awe and wonder let me roll,
And roll for ever. Who can satiate sight
In such a scene, in such an ocean wide
Of deep astonishment? Where depth, heighth, breadth,
Are lost in their extremes; and where to count
The thick-sown glories in this field of fire
Perhaps a seraph's computation fails. YOUNG.

The high-born soul
Disdains to rest her heaven-aspiring wing
Beneath her native quarry. Tired of earth
And this diurnal scene, she springs aloft
Through fields of air——————
She darts her swiftness up the long career
Of devious comets; through its burning signs
Exulting measures the perennial wheel
Of Nature, and looks back on all the stars
Whose blended light, as with a milky zone
Invests the orient. Now amazed, she views
Th' empyreal waste, where happy spirits hold
Beyond this concave heaven, their calm abode;
And fields of radiance, whose unfading light
Has travelled the profound six thousand years,
Nor yet arrives in sight of mortal things. AKENSIDE.

The stars being at such prodigious distances from the sun, cannot possibly receive from him so strong a light as they seem to possess, nor even a degree of brightness sufficient to make them visible to us; for his rays would be so scattered and dissipated before they could reach such remote objects, that they could never be transmitted to our eyes, so as to render those objects visible by reflection. The stars shine, therefore, by their own native and unborrowed lustre, and are totally different from the planets, which are opaque bodies, without any other light than what they receive from the sun.

> Ten thousand suns appear,
> Of elder beam; which ask no leave to shine
> Of our terrestrial star, nor borrow light
> From the proud regent of our scanty day.
>
> BARBAULD.

It is the opinion of the most enlightened philosophers, that each of these fixed stars is a sun, having worlds revolving round it, in the same manner as our earth and the planets revolve round our sun. For it is not to be imagined, that the Almighty, who ever acts with infinite wisdom, and does nothing in vain, should have created so many glorious suns, adapted to so many important purposes, and placed them at such distances from each other, without proper objects near enough to be benefited by their influence. To suppose that they were made only to give a faint glimmering light to the inhabitants of our globe, must bespeak a very unworthy opinion of the divine Wisdom; for many of the stars are so far from benefiting us, that they cannot be seen without the aid of a telescope; and the Deity, by an infinitely less
ertion of creative power, could have given
earth far greater light by only one additional

To a supposition so unphilosophical and absurd, some of our poets very happily allude:—

> When I behold this goodly frame, this world
> Of heaven and earth consisting, and compute
> Their magnitudes, this earth, a spot, a grain
> An atom, with the firmament compared
> And all her numbered stars, that seem to roll
> Spaces incomprehensible————
> ———————merely to officiate light
> Round this opacous earth, this punctual spot,
> One day and night, in all their vast survey
> Useless beside; reasoning I oft admire,
> How Nature, wise and frugal, could commit
> Such disproportions, with superfluous hand
> So many nobler bodies to create. MILTON.

> Ask for what end the heav'nly bodies shine?
> Earth for whose use? Pride answers, '’tis for mine:
> ———————— suns to light me rise,
> My footstool earth, my canopy the skies.' POPE.

> But do these worlds display their beams, or guide
> Their orbs to serve thy use, to please thy pride?
> Thyself but dust, thy stature but a span,
> A moment thy duration; foolish man!
> As well may the minutest emmet say,
> That Caucasus was raised to pave his way:
> The snail, that Lebanon's extended wood
> Was destined only for his walk and food:
> The vilest cockle, gaping on the coast
> That rounds the ample seas, as well may boast,
> The craggy rock projects above the sky,
> That he in safety at its foot may lie;
> And the whole ocean's confluent waters swell,
> Only to quench his thirst, or move and blanch his shell.
> PRIOR.

Every star, then, is the centre of a magnificent system, attended by a retinue of worlds, irradiated by its beams, and revolving round it by its active influence. Thus the greatness of God is magnified, and the grandeur of his empire made manifest. He is not glorified on one earth, or in one world alone, but in ten thousand times ten thousand. 'If *we could* wing our way to the highest apparent star, we should there see other skies expanded; other suns that distribute their inexhaustible beams of day; other stars that gild the alternate night; and other (perhaps nobler) systems established in unknown profusion through the boundless dimensions of space. Nor does the dominion of the universal Sovereign terminate there: even at the end of this vast tour we shall find ourselves advanced no farther than the suburbs of creation, the frontiers of the great Jehovah's kingdom.'

This mode of reasoning may be applied with greater force to the planets of our own system, and gains strength from other considerations. For who will presume to assert, that Infinite Love and Consummate Wisdom have formed such immense material masses (some of which greatly exceed our earth in size), convey them in revolutions round the sun, provide them with moons, and grant them the alternate change of day and night, and the vicissitudes of seasons, and all this only to emit their scanty light on our earth?

Who, that has seen any engine, a windmill for instance, and knows the use of it, if he travels into another country, and there sees an engine of the same sort, will not reasonably conclude that it is designed for the same purpose? When, therefore, we know, that the use of this planet, the earth, is for the habitation of various animals, and we see other planets at a distance from us, some larger and some smaller than our earth, moving round the sun, revolving on their axes, and attended by moons; is it not reasonable to conclude, that they are all designed for the same use as this earth is, and that they are habitable worlds, like the earth in which we reside?

Who can perceive them ' unpossessed
By living soul desert and desolate,

Only to shine yet scarce to contribute
Each orb a glimpse of light?" MILTON.

Who can imagine that the omnipotent Creator, who has not left a single drop of water unpeopled, and has filled every part of creation with animated existence, should leave such immense bodies destitute of inhabitants? It is surely much more rational to suppose them the abodes of intelligent beings; of beings endowed with capacities of knowing, loving, and adoring their Creator; provided and blessed with every object conducive to their happiness; many of them, perhaps, in a far greater state of purity than the inhabitants of our earth; in possession of superior degrees of bliss; and placed in situations, which furnish them with scenes of joy, equal to whatever poetry can paint, or religion promise; and all under the direction, indulgence, and protection of infinite Wisdom and Goodness[1].

In a word, it seems evidently to be the design of divine Providence, by this visible variety of worlds, to exalt our minds above this planetary globe, in search of that omnipotent Being upon whom all Nature is dependent; and the Creator, no doubt, in this immense display of his wisdom and power, designed the amazing whole as the adequate object of each part, and, as such, equally open on all sides to the penetrating progress of human minds; and through the most extensive faculty of sense, the sight, to draw our reason and understanding, by degrees, from finite objects to infinite; from the contemplation of terrestrial objects to the ultimate enjoyment of Himself in scenes of everlasting bliss:

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[1] See Young's Night Thoughts, vi. 174 to 190; ix. 1514 to 1532. Blackmore's Creation, ii. 526 to 542. *Prior's* Solomon, i. 502 to 535. Spectator, No. 420, 565.

For, from the birth
Of mortal man, the sov'reign Maker said,
That not in humble nor in brief delight,
Not in the fading echoes of Renown,
Power's purple robes, nor Pleasure's flow'ry lap,
The soul should find enjoyment: but from these
Turning disdainful to an equal good,
Through all th' ascent of things enlarge her view,
Till ev'ry bound, at length, should disappear,
And Infinite Perfection close the scene. AKENSIDE.

No. X.

ON THE FIGURE AND MOTION OF THE EARTH.

Qui tellurem medio libraverat axe. CLAUDIAN

The globe terrestrial, with its slanting poles,
And all its ponderous load, unwearied rolls.
BLACKMORE.

FROM the contemplation of the starry firmament, the infinite assemblage of worlds beyond worlds, and systems beyond systems, I now descend to a more particular consideration of our terraqueous globe.

My soul, unused to stretch her pow'rs
In flight so daring, drops her weary wing,
And seeks again the known accustomed spot,
Drest up with sun, and shade, and lawns, and streams,
A mansion fair and spacious for its guest,
And full replete with wonders. BARBAULD.

This vast body was long considered as a circular plane, extending on all sides to an infinite distance. The firmament above, in which all the heavenly bodies seem to move daily from east to west, was supposed to be at no great distance from this earth, and to have been created for its use and ornament. But this opinion, retained only by the vulgar and uninformed, I have sufficiently refuted in my preceding paper. It is now received as an incontestible truth, that the earth is nearly of a spherical figure, or resembling that of a globe.

It is not necessary to enter into any scientific researches, in order to demonstrate the truth of this doctrine. It is evident from its having been frequently sailed round. The first time was in the year 1519, when Ferdinand Magellan commenced a voyage round the whole globe, which he completed in 1124 days. In 1557, 8, and 9, Sir Francis Drake performed the same in 1056 days; in 1586 and 7, Sir Thomas Cavendish made the same voyage in 777 days; Simon Cordes, of Rotterdam, in the year 1590; and in 1598 to 1600, Oliver Noort, a Dutchman, in 1077 days; William Cornelius Van Schouten, in the year 1615, 16, in 749 days; James Heremites and John Huygens, in the year 1623, in 802 days; and many others have since performed the same circumnavigation. All these intrepid navigators, by sailing continually from east to west, at length arrived in Europe, whence they had set out; and, in the course of their voyage, they observed all the phenomena, both of the heavens and the earth, to correspond to this spherical figure.

Another evidence of this form is the circular appearance of the sea itself, and the circumstances which attend large objects, when seen at a distance on its surface: for when a ship is sailing from the shore, we first lose sight of the hull, afterward of the rigging, and, at last, discern the top of the mast only. This is evidently occasioned by the convexity of the water between the eye and the object; for, otherwise, the largest and most conspicuous part would be visible the longest.

When the glad ship shoots from the port
Upon full sail, the bulk first disappears,
And then the lower, then the higher sails;
At length the summit of the towering mast
Alone is seen. CAPEL LOFT.

Another proof is taken from the shadow of the earth upon the face of the moon in the time of an eclipse: for, as the moon has no light but what it receives from the sun, and the earth (during the eclipse) is interposed between them, the moon must be obscured, either totally, or in part. And since, in every lunar eclipse, which is not total, the obscure part always appears to be bounded by a circular line, the earth itself, for that reason, must be spherical: it being evident, that nothing but a spherical body can, in all situations, cast a circular shadow.

The little unevennesses on the surface of the earth, which are caused by mountains and valleys, afford no objection to its being considered as a round body: for the loftiest mountains bear less proportion to the vast magnitude of the earth, than the small risings on the coat of an orange bear to the orange itself; or, indeed, than a grain of sand to an artificial globe of a foot diameter. And accordingly we find, that these trifling protuberances occasion no irregularities in the shadow of the earth, during the time of a lunar eclipse. On the contrary, its circumference appears invariably to be as even and regular as if cast by a body perfectly globular.

This doctrine of the spherical figure of the earth is, undoubtedly, very antient; for, at the taking of Babylon, by Alexander the Great, eclipses were found to have been computed for many ages before the birth of Christ; which could not have been done without a knowledge of the globular figure of the earth. And Thales, the Milesian, who lived about 600 years before Christ, is said, by Herodotus, to have predicted an eclipse of the sun; which shows that he was sufficiently acquainted with the subject of eclipses in general. But it is also equally certain, that of this spherical figure of the earth, some of the greatest men in those times, were ignorant. Heraclitus imagined it to have the shape of a canoe; Anaximander supposed it to be cylindrical; and Aristotle, the great oracle of antiquity, and even of later ages, gave it the form of a timbrel.

The vulgar opinion, that the earth was a flat body, infinitely extended, and covered by the sky, in the form of a dome, continued to be the most universal, even so late as the fifteenth century. But a very little time before the discovery of America, the notion of the earth having a globular form was treated as an impious absurdity, contrary to the opinion of the most venerable fathers of the Church, and to some express declarations of the holy Scriptures[1]. The dictates of

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[1] These passages of Scripture are either ill understood, or strangely perverted from their real meaning. For it is evident that the sacred writers speak every where according to the common appearances of things, and were not so solicitous to instruct us in philosophy and astronomy, as to make us good men, by laying before us a plain rule of faith and conduct. Thus, when Joshua speaks of the sun and moon standing still, and Job describes the earth as being supported by pillars, they used the popular language of the times, without concerning themselves with the strict philosophical propriety of the terms they employed; the one being a historical relation, and the other a dramatical composition, in which such figures of speech have been always allowed; though Job himself, in another place, describes the earth as '*hung upon nothing*.' And even now, the most philosophical persons both in writing and conversation, speak of the progress of the sun, &c. in the popular way, according to the appearance of it, although contrary to the reality. Thus Thomson:

And now from Aries *rolls* the bounteous Sun,
And the bright Bull receives him

reason, however, with the voyage of Christopher Columbus, restored to the earth the spherical figure, which the ancient Egyptians and Chaldeans had given it: and it was then generally believed to be a perfect globe, and that the stars made their revolutions round it in circular orbits.

Of this opinion were the greatest philosophers of the age. A globe is the most perfect of all geometrical figures; and the manifest simplicity of Nature in most of her operations, seemed to favour the idea of the earth having such a form. This simplicity, however, appeared to be a false light, by which its followers were misled.—M. Richer, in a voyage to Cayenne, near the equator, found that the pendulum of his clock no longer made its vibrations so frequently as in the latitude of Paris; and that it was absolutely necessary to shorten it by a little more than the eleventh part of a Paris inch, to make it agree with the times of the stars passing the meridian.

Natural philosophy and geometry were then very far from being so much cultivated as they are at present; and who could have believed, says Voltaire, that from an observation so trifling in appearance, such a sublime and philosophical truth could spring? A pendulum, like any other falling body, is acted upon by the force of gravity, or the natural tendency of bodies toward their centre; and, in consequence of Richer's discovery, it was observed, that since the gravity of bodies is by so much the less powerful as those bodies are farther removed from the centre of the earth, the region of the equator must absolutely be much more elevated than that of France; and, consequently, the figure of the earth could not be that of a sphere.

The observations made at Cayenne might have been considered as too local and particular to admit of any satisfactory conclusion; but, as a like alteration was found to take place by subsequent observations in many different situations, we can no longer hesitate to receive it as a general phenomenon, arising from an actual diminution of gravity, in those places where the experiment was performed.

Newton and Huygens were the first who perceived the extensive application of which this discovery was capable; and, by pursuing it through all its consequences, they obtained the solution of a problem, which seemed beyond the reach of human abilities. This was no less than the determining the true figure of the earth.

It is a known property of the pendulum, that all its vibrations are made in the same time; and that the time in which each vibration is performed is in proportion to the square root of the length of the rod: thus a pendulum of thirty-six Paris inches in length, makes its vibrations in a second; and one of nine inches makes its vibrations in half a second; so that the shorter the pendulum, the more swiftly it moves; and the longer it is, the more slowly it moves; the ratio being always the same as that before mentioned.

The time, therefore, in which any pendulum performs its oscillations, depends as well upon the length of that pendulum, as upon the force which impels it toward the surface of the earth. If this force be diminished by any cause whatever, the body, with a less capacity for motion, will employ a longer space of time to move through the same space; and, in order that each vibration may be made in the same time that it was before this diminution took place, the length of the rod must be shortened, by which a new velocity will be *given to* it, that will be sufficient to supply the defect; and this was exactly the case in all the experiments made near the equator.

Gravity, then, it is evident, is less powerful under the equator than in those parts of the earth that lie near the poles. The limits of my paper will not permit me to enter into such an illustration of this, as would be satisfactory to the philosophical inquirer. I must be content, therefore, to observe, that there are two forces which act in direct opposition to each other. The first, which is called the *centrifugal* force, is a certain tendency of bodies to fly off from the centre round which they move. This may be made evident, by observing the whirling of a mop, or the turning of a stone swiftly round in a sling. The other force is called the *centripetal*. It is so called, because it is directed toward the centre, and, in the present case, is the same as *gravity*. It is next to be considered, that the diurnal motion of the earth is performed round an imaginary line, which passes through the two poles; and according to Sir Isaac Newton, as the equator is farther distant from its centre, than any other circle which is parallel to it, it is plain, that those parts of the earth which lie under the equator, will move with a greater velocity than those which are nearer to the poles; and, of course, the equatorial regions will become more elevated than the polar. Now, as every part of the earth gravitates towards the centre, in consequence of the centripetal force; and as this force is found to be about 289 times greater than the centrifugal force, which arises from the rotation of the earth upon its axis, a certain balance will constantly be maintained between them, and the earth will assume such a figure as would naturally result from the difference between these two contrary and opposite forces. Supposing, therefore, the primitive figure of the earth to have been that of a globe, which is the shape it would naturally assume from the action of the centripetal force, the opposite action of the centrifugal force must evidently change it into an oblate spheroid, or a body nearly resembling a turnip or an orange. And this is the true figure of the earth, as determined by Sir Isaac Newton, who found, by mathematical calculations, that the polar diameter of the earth is to the equatorial, as 229 is to 230; or that the regions of the equator are elevated about thirty-five miles more than those at the poles[1]. This great mathematical truth is farther confirmed by analogy; for it is easy to perceive, by a good telescope, that the planet Jupiter is flattened about his poles, in nearly the same manner as has been asserted of our earth; but as his rotation upon his axis is performed with a far greater rapidity than that of the earth, the alteration in his figure is found to be much more considerable; as would naturally follow from such a motion. The relation of his diameters, according to Newton, is nearly as 12 to 13, and the difference between his equatorial and polar diameters is about 6230 miles

I am now to consider the motion of the earth; and in this discussion nothing more is necessary, than to observe the common appearances of the heavens. The Sun and stars, it is well known, seem to move daily from east to west, and to return nearly to the same place in the heavens in twenty-four hours. It follows, therefore, that they must really move as they appear to do, or else that we ourselves must be moved; it being a self-evident principle, that if the situation of two bodies with respect to each other be changed, one of them, at least, must be moved.

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[1] This was upon the supposition that the matter of which the earth is composed is homogeneous: according to more recent and accurate hypotheses, confirmed by actual admeasurements, the ratio of the earth's axes is stated to be about that of 323 to 324.

But if this change be owing to the revolution of the stars, we must suppose them to be endued with a motion so amazingly swift as to exceed all conception. Their distances from us are so immense, and the orbits they have to run round so prodigiously great, that the nearest of them would move at least 100,000 miles in a minute. Now, as Nature never does that in a complicated and laborious manner, which may be done in a more simple and easy way, it is more consonant to reason, that these effects should be produced by the motion of the earth; especially, as such a motion will best account for all the celestial appearances, and, at the same time, preserve that beautiful simplicity and harmony, which are found to prevail in every other part of the creation. And it is much more probable, that the earth revolves round its axis, with an easy natural motion, once in twenty-four hours, than that such stupendous bodies as the Sun and stars (the former above a million times bigger than the earth) should be carried from one place to another with such incredible velocity.

It is no objection to the rotation of the earth, that we are unable to perceive it; for, as the motion of a ship at sea, when she sails swiftly over the smooth surface of the water, is almost imperceptible to the company on board; much more so must it be with such a vast body as the earth, that can meet with no obstacles to disturb its motion. Milton obviates this objection, by representing the earth advancing in her silent course,

> With inoffensive pace that spinning sleeps
> On her soft axle, while she paces even,
> And bears *us soft with the* smooth air along.

A balloon, turning upon its axis as it floats through the atmosphere, affords a sensible representation of the earth in its annual progress round the Sun, which is productive of the various vicissitudes of the seasons, winter, spring, summer, and autumn.

It has likewise been asserted, that if the earth moved, a stone dropped from the top of a tower, or any other high building, would not fall just at the bottom of it, as the building must have advanced considerably forward during the time of the fall. But it is well known, that if a body be projected from another body in motion, it will always partake of the motion of that other body. Thus, a stone dropped from the top of a mast, while the ship is under sail, is not left by the vessel, but falls exactly at the foot of the mast: and thus the atmosphere, as Milton has observed above, is likewise borne along with the earth.

This motion of the earth round its axis is called its diurnal motion, and is that which occasions the regular return of day and night, and all the celestial appearances before mentioned.—I could here descant with pleasure on the various beneficial consequences attending this daily revolution; but, as this would lead my present disquisition too far, I shall conclude with the sentiment of the Roman orator: 'Diei noctisque vicissitudo conservat animantes, tribuens aliud agendi tempus, aliud quiescendi. Sic undique omne ratione concluditur, mente, concilioque divino omnia in hoc mundo ad salutem omnium, conservationemque admirabiliter administrari.' And this reference of all things to the benevolent agency of the Supreme Being, is beautifully expressed by Mallet;

Thee, Nature's God!
The Source of all things lovely, all things good!—
[illegible] things own! Thou speakest, and it is day.

Obedient to thy nod, alternate night
Obscures the world. The seasons, at thy call,
Succeed in train, and lead the year around.

No. XI.

ON GRAVITY.

Thine these noble works
Great universal Ruler!
Thy virtual energy the frame of things
Pervading actuates; as at first thy hand
Diffused, through endless space, this limpid sky,
Vast ocean without storm, where these huge globes
Sail undisturbed, a rounding voyage each;
Observant all of one unchanging law.
Simplicity divine! by this sole rule,
The Maker's great establishment, these worlds
Revolve harmonious, world attracting world
With mutual love, and to their central sun
All gravitating. MALLET.

O, unprofuse magnificence divine!
O, wisdom truly perfect! thus to call
From a few causes such a scheme of things,
Effects so various, beautiful and great,
An universe complete. THOMSON.

MY late inquiries into the Solar System, the Plurality of Worlds, and the Figure and Motion f the Earth, naturally lead me to some considera- ions on Gravity, which is the most antient and niversal property of matter, and that, principally, y which the beauty, order, and harmony of the niverse are invariably maintained. The illustri- ous Newton has pursued his speculations on this ubject with such success, that, the most simple ature *of gravity being* supposed, he has established the true system of the world beyond all controversy, and explained clearly the most considerable phenomena of Nature. And his opinion of the nature and properties of gravity is this:

Every single particle, of all bodies whatever, gravitates to every single particle of all bodies whatever: that is, they are impelled toward each other by the force of gravity.

This gravitating force is universal as to the extent of it; that is, all bodies whatever, so far as we know, wherever they are placed, not only on the earth, but also in the heavens, whether in the Moon or planets, the Sun, or any other place, are endued with this power.

This force is also universal as to the *kinds* of bodies; that is, all bodies, whatever their figure, form, or texture be; whether they be simple or compound, solid or fluid; whether they be great or small, in motion or at rest; are endued with this power.

This force is also universal as to *time;* that is, all other conditions being the same, it never increases, nor diminishes.

The quantity of this gravity, at equal distances, is always exactly in proportion to the quantity of matter in the gravitating bodies: for instance, if a cubic foot of gold has a thousand pound weight upon the superficies of the earth, two cubic feet will have two thousand pound weight upon the same superficies; and if the earth contained but half the quantity of matter that it does now, the same cubic foot of gold, that has now a thousand pound weight upon the superficies of the earth, would have five hundred only.

The gravity of given bodies is greater or less, according to the distance of those bodies from *each other;* for example, a stone which, near the superficies of the earth, is very heavy, if it could be carried to a distance as high as the Moon, would be very light.

And, finally, the proportion of the increase or decrease of this gravity in bodies approaching to, or receding from, each other, is such, that its force is reciprocal in a duplicate proportion, or as the squares of their distances: for example, a body which, at the distance of ten diameters of the earth, weighs a hundred pounds, would, if its distance were but half as far, weigh four times as much; and if but a third part as far, nine times as much. In like manner, the force which, upon the superficies of the earth, would support a hundred pound weight, if it were twice as far off the centre, could support four times the weight, and, if at three times as far off, could support nine times the weight.

It must be observed, moreover, that the motion of falling bodies is increased, in successive intervals, in the proportion of odd numbers, 1, 3, 5, 7, 9, &c. so that the spaces they run through are as the squares of the times; that is, if a heavy body descended one foot in a second of time, it would descend four feet in two seconds, nine feet in three seconds, &c. Or correctly, at least in the latitude of London, a body falling freely, passes through $16\frac{1}{12}$ feet in the first second; four times $16\frac{1}{12}$, or $64\frac{1}{3}$ feet, in the first two seconds; nine times $16\frac{1}{12}$, or $144\frac{3}{4}$ feet in the first three seconds; and so on.

Such are the principal properties of gravity, from the observation of which our immortal Newton deduced his sublime theory of the universe. It may be pleasing to the reader, to know the very simple incident, which, leading to the most extensive and complicated calculations, was productive of these noble and *wonderful* discoveries. It is thus related, on the authority of his friend and commentator, Dr. Pemberton:

Happening one day, in the year 1666, when only twenty-five years of age, to be sitting under an apple tree, an apple falling upon his head, suggested a variety of reflections. The phenomena of falling bodies in particular engaged his attention; and, extending his researches to the heavens, he began to investigate the nature of motion in general. Because there is motion, he reasoned, there must be a force that produces it. But what is this force? That a body, when left to itself, will fall to the ground, is known to the most ignorant; but if you ask them the reason of its thus falling, they will think you either a fool or a madman. The circumstance is too common to excite their wonder, although it is so embarrassing to philosophers, that they think it almost inexplicable.

It is impossible to follow this great philosopher through all his reasonings; but we may recapitulate some of the principal phenomena of this simple, yet wonderful, this obvious, yet mysterious law of nature. If I take a stone, and let it drop from my hand, it falls immediately to the ground, and would fall still farther, if there was a hole in the earth, and nothing to prevent its passage. In like manner, when a stone, or any other substance, is placed upon a table, it presses the table with the same force by which it would fall to the ground, if left to itself; and when a body is suspended at the end of a string, the force that impels it downward, stretches the string, and, if it be not sufficiently strong, will break it.

The cause of this falling propensity in all bodies, whatever it be, is called Gravity, Gravitation, or Attraction; and when a substance is said to be heavy, nothing more is meant, than a reference to the tendency which it has to fall to the ground, or to the force with which it presses on any substance that supports it. The *weight* and *gravity* of a body, therefore, may be taken for the same thing in different senses, for both refer to the force by which the body is impelled toward the earth; *gravity* being the tendency of bodies towards the centre of the earth; *weight*, the force which is necessary to counteract that tendency, or to prevent its producing motion downwards.

The antients were very imperfectly acquainted with this obvious property of bodies. They believed that there were substances, such as vapours and smoke, which from their light nature would ascend. There is no foundation, however, for opinion, nor for that of absolute levity in general; for, in a space void of air, all bodies whatever, smoke or a stone, a feather or a guinea, fall to the bottom in the same time. The distinction, therefore, between light and heavy bodies is merely relative; as they have all a similar propensity to fall to the earth.

The same body, conveyed to different places upon the surface of the earth, will not always have the same weight: for the weight of a body under the equator (as I demonstrated in my last paper) is less than at either of the poles; and in every other situation, it varies in a certain proportion to the latitude of the place. For the centrifugal force produced by the rotatory motion of the earth round its axis is opposed to the force of gravity, is greatest at the equator, least at the poles, and at intermediate points varies as the *square of the cosine of the latitude*: the gravity of a body, therefore, will be least at the equator, it will continually increase with the latitude of the place, and will be greatest at the poles.

The earth is nearly a globe, and gravity acts perpetually in straight lines, which are perpendicular to its surface. Suppose a hole could be bored through it, and that a body were placed at the centre, what would be its weight? Evidently nothing: it would remain in that situation, unsuspended and unsupported. The force of gravity being constantly directed toward the centre, it could have no propensity to move either way, and would, therefore, have no weight. For the same reason, if a body were thrown into this hole, from the surface of the earth, the velocity acquired by the repeated impulses of gravity during the time of its fall, would carry it to the opposite extremity of the perforation, whence it would return, and continue to move backward and forward for ever, if the medium had no resistance. These two cases may be illustrated by the pendulum of a clock, which, if once stopped, would move no more, till put again into motion by some impelling force, when (supposing the constant action of the weight) it would continue its vibrations.

In applying his reflections on the nature of falling bodies to the celestial motions, Newton soon perceived, that the force of gravity was not confined to the surface of our globe; it being found to act alike at the bottom of the lowest vallies, and at the summit of the most lofty mountains. This led him to conjecture, that it might extend as far as the Moon, and be the means of retaining her in her orbit. Imagine the Moon, he reasoned, at the first moment of its creation, to have been projected forward, with a certain velocity, in a rectilinear direction; then, as soon as it began to move, gravity would act upon it, and impel it toward the centre of the earth. But as a body, impelled by two forces, will follow the direction of neither, the Moon, so circumstanced, would neither proceed directly forward, nor fall directly downward, but keep a middle course, and move round the earth in a curvilinear orbit.

This may be more fully illustrated, by attending to the motion of a shot, or any other projectile. A ball shot from the mouth of a cannon, in a horizontal direction, does not fall to the ground till it has proceeded to a considerable distance; and if it be discharged from the top of a high mountain, it will fly still farther before it comes to the earth. Increase the force and the height, and the distance will be augmented accordingly. And thus, in imagination at least, we can suppose the ball to be discharged with such velocity, that it will never come to the ground, but return to the place whence it set out, and circulate continually round the earth, in the manner of a little moon.

Thus proceeding in his reflections, Newton discovered the admirable provision of the great Creator to prevent the evagation of the planets, and to retain them exactly within the bounds of their orbits. This he has demonstrated to be effected by gravity, and that gravity and motion completely solve all the phenomena of the planetary revolutions, both primary and secondary. By establishing this one principle in philosophy he has fully explained the system of the world, so far as it relates to this globe, and to all the rest of the planets that regard the Sun as their centre.

Such is the Newtonian system of universal gravitation or attraction. But what is this principle, which gives life and motion to inanimate beings, and how does it act? The effects are visible, but the agent that produces them is hidden from our senses. It eluded the search of Newton himself; he that soared to the utmost regions of space, and looked through nature with the eye of an eagle, was unable to discover it[1]. Indeed, he did not attempt to assign the cause; it not being his intention to engage himself in framing hypotheses, but to explain the phenomena by experiments only, and to raise his noble superstructure on them. And, therefore, although the facts themselves, and the final causes, are evident, I will not presume to say, how it can come to pass, that bodies act at such immense distances from one another; but would rather acquiesce in adoring the wisdom and power of the great Author of all things, who has inspirited the materials of which the universe consists with such an active quality, as not only serves to preserve the planets themselves entire[2], but to enable them to revolve about their luminous centres, in orbits at once the most convenient, invariable, and permanent.

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[1] That there is, however, such a principle, is not to be doubted. To deny its existence, would be to deny the truth of facts, established by experiment and demonstration. That two distant bodies will approach toward each other, without any visible agent, either attracting or impelling them, may be made manifest by various instances. The loadstone and a piece of iron mutually attract each other: two cork balls, swimming in water, approach together, and meet; and in electricity, we have numberless experiments to show, that several other bodies have the like propensity to unite and adhere to each other. These bodies, it is true, act by particular laws, different from that of gravity; but they serve sufficiently well to illustrate the nature of that principle. *Bonnycastle's Introduction to Astronomy*, page 119.

These principles I consider, not as occult qualities supposed to result from the specific forms of things, but a general law of nature, by which the things themselves are formed; their truth appearing to us by phenomena, though their causes be not yet discovered. For these are manifest qualities, and their causes only are occult, &c.—*Newt. Opt.* p. 374.

[2] Besides the beneficial effects of gravity, in causing, by the lunar influence, the diurnal variations of the tides, we shall find, in another respect, how much this great law of nature is subservient to the good, and even to the very existence, of our globe and all the planets; and that is, in *the preservation* of their integrity against the effects of *their diurnal* revolutions. For, with[illegible]uch a band as

> O Sun!
> Soul of surrounding worlds! in whom best seen
> Shines out THY MAKER——
> 'Tis by thy secret, strong *attractive* force,
> As with a chain indissoluble bound,
> Thy system rolls entire; from the far bourne
> Of utmost[2] Saturn, wheeling wide his round
> Of thirty years; to Mercury, whose disk
> Can scarce be caught by philosophic eye,
> Lost in the near effulgence of thy blaze.
>
> THOMSON.

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gravity to keep their parts entire, the whirling about of those globes would shatter them to pieces, and scatter them into the circumambient space. 'Thus (says Dr. Derham) must it needs befal our own globe, which whirls about at the rate of above 1000 miles an hour, and is composed of earth and water, materials of much too loose a texture to prevent the dissipation, which the centrifugal force of such a rotation must necessarily occasion about the equatorial parts: a rotation that would as easily throw off the parts of the earth, especially the waters, as the whirling round of a wheel or a globe would the loose dust and water lodged thereon. But by reason the gravitating power exceeds the centrifugal, as 2174 exceeds 7,54064, that is, above 288 times; therefore all parts lie quiet and secure in their respective places, and enjoy all the benefits which accompany this motion, without any disturbance from it.' *Astro-Theology*, b. vi. ch. 2.—He adds, that this is far more remarkable in the Sun, which revolves round its axis, at the rate of 4262 miles an hour; and of Jupiter, which, at its equator, revolves round at the hourly rate of 38,159 miles.

[1] Gravity, or the weight of bodies, is not any accidental effect of motion, or of any very subtile matter, but an original and general law of all matter, impressed upon it by God, and maintained in it perpetually by some efficient power, which penetrates the solid substance of it; for gravity never is in proportion to the superficies of bodies, or of any corpuscles, but always to the solid quantity of them. Wherefore we ought no more to inquire how bodies gravitate, than how bodies began first to be moved.—*Dr. Clarke's Notes on Rohault*, part ii. ch. 28.

[2] The Georgian planet being then unknown.

No. XII.

ON THE CLOUDS;

Including the Theory of Evaporation.

'*Who can number the clouds in wisdom?*' JOB.

Ye mists and exhalations that now rise
From hill or steaming lake, dusky or gray,
Till the sun paint your fleecy skirts with gold,
In honour to the world's Great Author rise,
Whether to deck with clouds th' uncoloured sky,
Or wet the thirsty earth with falling showers,
Rising or falling, still advance His praise.
MILTON.

THE radiant orbs which adorn the night are not the only objects above to attract the philosophic eye. The firmament exhibits inexhaustible subjects of contemplation in a vast variety of igneous, aërial, and aqueous meteors. The latter, which are composed of vapours, or watery particles variously separated and condensed by heat and cold, form the clouds, with all the phenomena of rainbows, hail, snow, rain, dew, &c.[1]

The beautiful, and very often fantastic, appearances of the clouds, have not escaped the observation of the poets:

Sometime, we see a cloud that's dragonish;
A vapour, sometime, like a bear or lion,
A towered citadel, a pendent rock,
A forked mountain, a blue promontory

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[1] The igneous or fiery meteors are lightning, aurora borealis, ignis fatuus, draco volans, falling stars, and other fiery phenomena; an account of which will be given hereafter.—The aërial or airy meteors consist of flatulent and spirituous exhalations; such as winds, whirlwinds, and hurricanes; for an account of which see No. II.

With trees upon 't that nod unto the world,
And mock our eyes with air.——
That which is now a horse, even with a thought
The rack dislimns, and makes it indistinct
As water is in water. SHAKSPEARE.

When first the sun too powerful beams displays,
It draws up vapours which obscures his rays:
But even those clouds, at last, adorn its way,
Reflect new glories, and augment the day. POPE.

The sun has lost his rage; his downward orb
Shoots nothing now but animating warmth,
And vital lustre: that, with various ray,
Lights up the clouds, those beauteous robes of heaven,
Incessant rolled into romantic shapes,
The dream of waking fancy!
THOMSON.

At the Tropics, the clouds roll themselves into enormous masses, as white as snow, turning their borders into the forms of hills, piling themselves upon each other, and exhibiting the shapes of mountains, caverns, and rocks. There, as we collect from St. Pierre[1], may be perceived, amid endless ridges, a multitude of valleys, whose openings are distinguished by shades of purple and vermillion. These celestial valleys exhibit, in their various colours, matchless tints of white, melting into shades of different colours. Here and there may be observed torrents of light, issuing from the dark sides of the mountains, and pouring their streams, like ingots of gold and silver, over rocks of coral. These appearances are not more to be admired for their beauty, than for their endless combinations, since they vary every instant. What, a moment before, was luminous, becomes coloured; what was coloured mingles into shade; forming singular and most beautiful representations of islands and hamlets, arched bridges stretched over wide rivers, immense ruins, huge rocks and gigantic mountains.

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[1] Studies of Nature.

The clouds frequently, among the Highlands of Scotland, display the finest outlines and assume the most lovely characters; more especially, when viewed from the cones of their wild and magnificent summits. To these landscapes, sketched with such boldness in the heavens, Dr. Beattie finelly alludes, in his poem of the Minstrel.

> Oft when the wintry storm had ceased to rave,
> He roamed the snowy waste at even, to view
> The cloud stupendous, from th' Atlantic wave,
> High-towering, sail along the horizon blue;
> Where 'midst the changeful scenery, ever new,
> Fancy a thousand wondrous forms descries,
> More wildly great, than ever pencil drew;
> Rocks, torrents, gulfs, and shapes of giant size,
> And glittering cliffs on cliffs and fiery ramparts rise.
> *Minstrel*, Part i. st. liii.

Bloomfield describes the appearance of clouds, of a fine moonlight night, in a manner worthy the pen of Virgil:

> Low on the utmost bound'ry of the sight,
> The rising vapours catch the silver light;
> Thence fancy measures, as they parting fly,
> Which first will throw its shadow on the eye,
> Passing the source of light; and thence away,
> Succeeded quick by brighter still than they.
> For yet above these wafted clouds are seen
> (In a remoter sky, still more serene)
> *Others, detached in ranges thro' the air,*
> *Spotless as snow, and countless as they're fair;*
> *Scattered immensely wide from east to west,*
> *The beauteous semblance of a flock at rest.*
> *These, to the raptured mind, aloud proclaim*
> *Their* MIGHTY SHEPHERD'S EVERLASTING NAME[*].
> *Bloomfield's Winter*, l. 249.

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[*] See this subject pursued in the *Philosophy of Nature* Vol. I. p. 101. one of the most elegant and interestin *works* which modern times have produced.

A cloud is a collection of condensed vapour, suspended in the atmosphere. In other words, a cloud is a congeries of watery particles, or vesiculæ, raised from the waters, or watery parts of the earth, by the solar, or subterraneous, or electrical fire. These watery particles, at their first rise from our globe, are too minute, and too much separated by their mutual repulsion, to be perceived; but as they mount, meeting with a greater degree of cold, losing their electricity, or by some process employed by nature for this purpose, they are condensed, and rendered opaque, by the reunion of their parts, so as to reflect light, and become visible.

There are few subjects of philosophical investigation that have occasioned a greater variety of opinions than the theory of evaporation[1]; the manner in which vapours are raised into clouds; or the ascent of water in such a fluid as air, between eight and nine hundred times lighter than itself, to different heights according to the different densities of the air; in which case it must be specifically lighter than the air through which it ascends.

The Cartesian philosophers, with Dr. Nieuwentyt, Dr. Halley, Dr. Desaguliers, and others, have had recourse, but upon different principles, to *heat*, as the sole cause of evaporation. But it has

[1] The terms *exhalation* and *vapour* are ordinarily used indifferently: but the more accurate writers distinguish between them; appropriating the term *vapour* to the moist fumes raised from water and liquid bodies; and *exhalation* to the dry ones emitted from solid bodies; as earth, fire, minerals, sulphurs, salts, &c. In this sense, exhalations are dry subtile corpuscles, or effluvia, loosened from hard terrestrial bodies, either by the heat of the sun, or the agitation of the air, or some other cause; and emitted upward to a certain height of the atmosphere, where, mixing with the vapours, they help to constitute clouds, and return in dews, mi rains, &c.

been shown, that the evaporation of water is so far from depending on its being rarefied by heat, that it is carried on even while water is condensed by the coldness of the air, for water is gradually condensed by the cold till it freezes; and since it evaporates even when frozen into hard ice, it must also evaporate in all the less degrees of cold. Heat, therefore, does not seem to be the principal, much less the only, cause of evaporation.

Other philosophers have attempted to account for evaporation on a different principle, namely, that of *solution*; and they have shown, from a variety of experiments, that what we call evaporation is nothing more than a gradual solution of water in air, produced and supported by the same means, or by attraction, heat, and motion, by which other solutions are effected. The idea of this hypothesis appears to have been first started, in 1743, by Abbé Nollet: it was afterward adopted and pursued by Dr. Franklin, M. le Roi, and others; and, in 1765, it was first established as the true theory of evaporation, by Dr. Hamilton.

By solution, Dr. Hamilton understands, with other writers, such an intimate union between the particles of a body and those of a fluid, that the whole shall appear a homogeneous mass, as transparent as the fluid was before such union, and shall continue so until some external cause produces a change. He considers the transparency of the fluid as the criterion of true solution, and that which distinguishes it from a mixture. He proceeds to show, that there is a mutual attraction between the water and air, of the same kind with that which is observed between the particles of any two bodies, one of which dissolves the other. All water contains a considerable quantity of air, which may be separated from it; and as the air retains its elasticity, we may reasonably suppose that it is prevented from escaping by the force of attraction, just as the particles of gold are suspended in aqua regia, by their attraction toward the particles of that fluid. Moreover, water exhausted of its air will again imbibe a certain quantity, gradually drawing it into its pores till it is saturated, just as a lump of sugar draws water into its pores. Air, likewise, evidently contains a quantity of water, which will be drawn from it, even in its purest and driest state, by dry salt of tartar, so that the salt will become entirely fluid; and yet, in this case, the air is perfectly transparent. There is also a remarkable similarity between the properties of common solution and those of evaporation. As salt, beginning to dissolve in water, appears at first to thicken the water that surrounds it, and the solution of it to be promoted by agitation; so, in like manner, the air, that lies at rest over water, appears thick, and loaded with aqueous particles; in which case the evaporation proceeds very slowly, but is greatly promoted by a current of fresh air passing over the exhaling surface.

When a lump of any salt is dissolved in clear cold water, the water that is first saturated with it will rise, on agitation, in curled wreaths, through the other water, render it somewhat opaque, and give an apparent tremulous motion to an object seen through it, till by degrees the solution is complete, and the transparency of the water is restored: the case is the same when any two fluids of different densities that will incorporate, are mixed together; thus, smoke or steam, when it first rises into the air, exhibits similar appearances; and the vapour rising in a hot day from moist ground will make the air, and any objects seen through it, appear to have a tremulous motion, which is still more observable when a telescope is used, that magnifies the floating vapours. Moreover, heat, by expanding bodies, enlarging the pores, and lessening the mutual cohesion of their particles, promotes, and cold, on the contrary, in some measure retards and checks both solution and evaporation. As very hot water dissolves salt sooner, and in a greater quantity, than cold water, and, when cooled, deposits part of the salt after a strong solution, which was before dissolved; so water will evaporate faster in warm than in cold air; and, therefore, the air is generally clearer in cold than in hot weather. Thus, the aqueous vapours suspended in the air during the heat of the day, fall down at night, and form themselves into drops of *dew;* or if the night be very cold, appear next morning crystallized in a *hoar-frost.* If a bottle of very cold liquor be exposed to the warm air in a hot day, the air contiguous to it being cooled, will let go part of its water, which will form a dew on the outer surface of the glass. By an experiment similar to this, M. le Roi was first led to conclude, that water is really dissolved in air: for the same reason a dew is formed on the inside of the windows of a warm room, which on their outside are exposed to the cold air: again, the quantity of a body dissolved, and of a fluid evaporated, depends, *cæteris paribus,* on the quantity of surface.

It is to be observed, that there is a stronger attraction or affinity between spirit of wine and air than between water and air; and it being known that the spirit evaporates much faster than the water, the evaporation of fluids seems to arise from an attractive force between their particles and those of air. Finally, after dissolving a body in any proper menstruum, if another body which has a greater affinity to the menstruum be added, this will be dissolved, and the first will be precipitated; and in the same manner, any fluid will let go the air which it contains, on the addition of another body to which it has a greater affinity than it has to the air: from which fact it may be inferred, that the air, imbibed by any fluid, is, properly speaking, dissolved in that fluid; and therefore that any fluid which evaporates, or is imbibed by the air, is also, properly speaking, dissolved in the air.

Dr. Hamilton having thus evinced the agreement between solution and evaporation, concludes, that the latter is nothing more than a gradual solution of water in air, produced and promoted by attraction, heat, and motion, just as other solutions are effected.

In order to account for the ascent of aqueous vapours into the atmosphere, this ingenious writer observes, that the lowest part of the air being pressed by the weight of the upper against the surface of the water, and continually rubbed upon it by its motion, attracts and dissolves those particles with which it is in contact, and separates them from the rest of the water. And since the cause of solution, in this case, is the stronger attraction of the particles of water toward the air than toward each other, those that are already dissolved and taken up will be still further raised by the attraction of the dry air which lies over them, and thus will diffuse themselves, rising gradually higher and higher, and thereby leave the lower air not so much saturated, but that it will still be able to dissolve and take up fresh particles of water; which process is greatly promoted by the motion of the wind. When the vapours are thus raised and carried by the winds into the higher and colder parts of the atmosphere, some of them will coalesce into small particles, which slightly attracting each other, and being intermixed with air, will form *clouds*; and these clouds will float at different heights, according to the quantity of vapour borne up, and the degree of heat in the upper parts of the atmosphere. The clouds, therefore, are generally higher in summer than in winter; and this effect of renovated warmth, on the departure of winter, is thus described by Thomson:

> At last from Aries rolls the bounteous Sun,
> And the bright Bull receives him: then no more
> Th' expansive atmosphere is cramped with cold,
> But, full of life and vivifying soul,
> *Lifts the light clouds sublime*, and spreads them thin,
> Fleecy and white, o'er all-surrounding heaven.

When the clouds are much increased by a continual addition of vapours, and their particles are driven close together by the force of the winds, they will run into drops heavy enough to fall down in *rain*. If the clouds are frozen before their particles are gathered into drops, small pieces of them, being condensed and made heavier by the cold, fall down in thick flakes of *snow*[1]. If the particles are formed into drops before they are frozen, they become *hail-stones*. When the air is replete with vapours, and a cold breeze springs up, which checks the solution of them, clouds are formed in the lower parts of the atmosphere, and compose a *mist* or *fog*, which usually happens in a cold morning, and is dispersed when the sun has warmed the air, and made it capable of dissolving these watery particles. Southerly winds generally bring rain, because, being commonly warm and replete with aqueous vapours, they are cooled by passing into a colder climate, and therefore part with some of them, and suffer them to precipitate in rain: whereas northerly winds being cold, and acquiring heat by coming into a warm climate, are ready to dissolve more vapour than they before contained; and therefore, by long continuance, they are dry and parching, and usually attended with fair weather.

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[1] See an account of this curious, beautiful, and very useful phenomenon, in No. III.

Changes of the air, with respect to its density or rarity, as well as its heat and cold, will produce contrary effects in the solution of water and the consequent ascent or fall of vapours. Several experiments prove, that air, when rarefied, cannot keep as much water dissolved as it does in a more condensed state; and therefore, when the atmosphere is saturated with water, and changed from a denser to a rarer state, the higher and colder parts of it will let go some of the air before dissolved, form new clouds, and dispose them to fall in rain: but a change from a rarer to a denser state will stop the precipitation of the water, and enable the air to dissolve, either in whole or in part, some of those clouds which were formed before, and render their particles less apt to run into drops, and fall down in rain: on this account we generally find that the rarefied and condensed states of the atmosphere are respectively attended with rain or fair weather.

Such is Dr. Hamilton's theory of evaporation, on the new principle of solution; which is not only the most plausible, but now the most generally received [1].—I shall conclude this paper by observing, that the clouds are not only, at times, among the most picturesque and pleasing, but among the most useful phenomena of nature. This is manifest from the refreshing shade which the clouds afford, particularly in the torrid zone. How obviously, too, do they contribute to the fertility of the earth, by the refreshing dews and showers which they shed over all the tribes of vegetation, which would otherwise languish and die with perpetual drought, but, cherished by these, now flourish with the brightest verdure, and in all the variety of Nature's tints; so that the Contemplative Philosopher may, with great propriety, adopt the language of the Psalmist, '*Thou visitest the earth, and waterest it—Thou makest it soft with showers; thou blessest the springing thereof—The little hills rejoice on every side*; *the pastures are clothed with flocks: the vallies also are covered over with corn; they shout for joy; they also sing!*'

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[1] This theory, however, has of late been considerably modified and improved. The results of Dalton and Gay-Lussac are very interesting: for an account of them we refer to the 1st vol. of Dr. Gregory's translation of M. Haüy's Natural Philosophy.

Clouds, according to the nomenclature of Mr. Luke Howard, are distinguished by seven modifications, the peculiarites of which seem to be caused by the agency of electricity: for example, three primary modifications, the *Cirrus*, the *Cumulus*, and the *Stratus*: two of which may be considered as intermediate in their nature, the *Cirrocumulus* and *Cirrostratus*; one which appears to be a compound, the *Cumulostratus*; and, lastly, the *Cumulocirrostratus*, or *Nimbus*, a state which immediately precedes the resolution of clouds into rain.

1. *Cirrus.*—The cirrus is a cloud which appears to have the least density, and generally the most elevation, and which has the greatest variety of extent and direction. It may truly be called the *Proteus of the skies*; for, in some kinds of weather, its figure is so rapidly and so continually changed, that after turning the eye away from it for a few minutes, it will frequently be found so completely altered as scarcely to be identified as the same cloud. This, however, is not always the case; it

is sometimes visible for many hours, and even days together, without much changing its appearance.

After a continuance of clear weather, the cirrus is frequently the first cloud which is seen. In this case it often looks like a fine whitish thread, pencilled, as Mr. Howard expresses it, on the clear blue sky: to this, other faint lines of the same kind are added laterally; they increase in size and length, and often serve as stems from which numerous branches proceed, and become other cirri of the same kind.

2. *Cumulus.*—This is a convex aggregate of watery particles increasing upwards from a horizontal base. It is commonly of a dense structure, formed in the lower atmosphere, and moving along in the current of wind which is next to the earth. Its first appearance is generally a small irregular spot, which becomes the nucleus on which it forms. This increases in size, preserves a flat horizontal base, and assumes somewhat of a conical figure. Cumuli vary a little in shape and dimensions, according to peculiarities in the operation of the causes which produce them. Sometimes they are pretty well defined hemispherical masses; at others, they rise into mountains, ranged in one plane, their silvery summits presenting a beautiful appearance.

3. *Stratus.*—The stratus is the lowest of clouds; its under surface usually rests on the earth or water. It may properly be called the *cloud of night*, as it frequently makes its appearance about sunset, and disappears soon after sunrise. When ascending in the atmosphere, it often seems to take the form of cumulus. It comprehends what we usually call fogs and mists, which in fine summer evenings are seen to ascend in spreading sheets from valleys, akes, and fields. In autumn or winter it someimes continues throughout the day. It must be emembered, however, that all fogs are not strati;

some appear to be of the modification of cirrostratus.

4. *Cirrocumulus.*—After the cirrus has ceased to conduct the electric fluid, it probably either disappears by dispersion or evaporation, or it changes into the cirrocumulus or cirrostratus. Its change to the cirrocumulus is frequently marked by the following circumstances: it loses its cirriform and fibrous structure, descends lower in the atmosphere, and assumes the form of a number of well defined and roundish little clouds, lying in close horizontal arrangement: the change is more or less rapid on different occasions, and sometimes takes place in part of the cloud, while the other part remains cirriform, or approaches to the nature of cirrostratus. The cirrocumulus is frequent in summer, and often forms very beautiful skies: at all times of the year it may be seen, in the intervals of showers, and before an increase of temperature, of which its prevalence is a pretty certain prognostic.

5. *Cirrostratus.*—In speaking of the cirrus, it has been observed that, that cloud frequently changed into some other. Its change is generally into either the cirrocumulus or cirrostratus: when it passes to the latter, it descends lower in the atmosphere, its fibres become denser and more regularly horizontal, and it generally appears subsiding, or altering its form. The figure of the cirrostratus, like that of the cirrus, is very various: sometimes it consists in dense longitudinal streaks; at others it looks like shoals of fish; sometimes the whole sky is so mottled with it as to give the idea of the back of the mackerel; and hence called the mackerel-back sky. It frequently appears like the grains of polished wood, or is composed of fine fibres, disposed after the manner of the fibres of muscles, which often intersect each other.

6. *Cumulostratus.*—The change of the cumulus

into the cumulostratus is effected in the following manner: The cumulus, losing its hemispherical figure, increases irregularly upward, grows more dense, and overhangs its base in uneven or rugged folds: a pre-existing cirrus, cirrocumulus, or cirrostratus, or one perhaps immediately formed for the occasion, alights on its summit, and inosculates. The cumulostratus varies in appearance: sometimes it overhangs a perpendicular stem, and looks like a great mushroom; frequently a long range of cumulostrati appear together, which have the appearance of a chain of mountains with silvery tops. Before thunder-storms it seems frequently reddish, which some have imagined to arise from its being highly charged with the electric fluid.

7. *Nimbus.*—Clouds of any one of the above-mentioned modifications, at the same degree of elevation, may increase so much as completely to obscure the sky: two or more different modifications may also do the same thing in different elevations, and the effect of this obscuration may be such as would induce an inattentive observer to expect the speedy fall of rain. It appears, however, from attentive observation, that no cloud effuses rain until it has previously undergone a change sufficiently remarkable to constitute it a distinct modification, to which the term *nimbus* has not inaptly been applied.

The best time for viewing the progress of nimbification is by stormy weather; cumuli may then be seen rising into mountains and becoming cumulostrati, while long strata of cirrostratus permeate their summits; and the whole phenomenon has the appearance of a range of mountains, transfixed by the mighty shafts of giants. After having existed some while in this form, they become large and irregular, and they get darker by intensity, till all seem concentrated in a dense black mass, with a cirrose crown extending from the top, and ragged cumuli entering from below, and eventually the whole resolves itself into rain[1].

No. XIII.

ON THE DIVINE WISDOM AND GOODNESS IN THE WONDERS OF THE AIR.

> At nusquam emicuit pia cura et mira potestas
> Splendidior, quam quod tanta ille effinxerit arte
> Aëra, qui semper vitæ spiramina nutrit. C******.
>
> But not alone in yon stupendous spheres
> His power immense, his majesty appears:
> We view his kind, his life-preserving care,
> In all the wond'rous properties of air. LOBB.

AIR, in a general sense, is that invisible fluid surrounding our globe, on which depends not only animal but vegetable life; and which seems, in short, to be one of the great agents employed by Nature, in carrying on her operations throughout the world.

Though the attention of philosophers, in all ages, has been employed, in some measure, by inquiries concerning the nature of the atmosphere, yet, till the year 1750, little more than the mere mechanical action of this fluid was discovered, with the existence of some anomalous and permanently elastic vapours, whose properties and relations to the air we breathe were almost entirely unknown. Since that time, however, the discoveries concerning the constituent parts of the atmosphere itself, as well as the nature of the different permanently elastic fluids that go under the general name of *air*, have been so numerous and rapid, that they have, at once, raised the subject to the dignity of a science, and now form, under the name of *aëro-logy*, a very important part of the modern system of natural philosophy.

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[1] See *Forster's Researches about Atmospheric Phenomena*, a second edition of which has lately been published, much enlarged.

These discoveries, indeed, have not been more nteresting to philosophers, than useful to science nd beneficial to society. Many perplexing pro-esses in chemistry have been explained in con-equence of them; several have been facilitated; nd a number of new and useful ones have been ntroduced. The phenomena attending metallic alcinations and reductions have been greatly elu-idated. The knowledge of the use of the air in espiration; the method of ascertaining its purity nd fitness for that function; the investigation of ephlogisticated air; the method of impregnating ater with fixed air; are all calculated to answer urposes of the highest utility. The medicinal roperties of fixed air have been, in a great easure, ascertained; and its antiseptic qualities, n other respects, promise to be of considerable dvantage. The method of ascertaining the purity f the air of a place, and the manner of ventilating n apartment, are of great use to those concerned n public buildings. In short, there is, perhaps, o station in life where some knowledge of this ubject may not be of use; and yet, interesting nd important as are these discoveries, they were nknown, not to the antients only, but to the Bacons, the Newtons, the Boyles, and other illustrious philosophers of the 17th century[1].—A very minute and particular inquiry into this subject cannot be expected in the limits of a short essay. Volumes have been written upon it, the invaluable acquisitions of the most patient and laborious investigation. To these, therefore, and particularly to the Observations and Experiments of Dr. Priestley, I must refer my more curious and inquisitive readers.

For many ages the air was supposed to be a simple and homogeneous fluid; its common operations to depend on its heat, cold, moisture, or dryness; and any effects which could not be explained by these (such as the appearance of pestilential diseases) were thought to be entirely supernatural, and the immediate effects of the divine Power. It was reserved for Dr. Priestley to make the great discovery concerning the nature of our atmosphere; and to inform the world, that it is composed of two fluids; the one absolutely noxious, and incapable of supporting animal life for a moment; the other extremely salutary, and capable of preserving animals alive and healthy for a much longer time than the purest air we can meet with. The first of these he called *phlogisticated air*; that is, the combination of common air with *phlogiston*, which, in chemistry, is defined to be the most pure and inflammable principle; a principle existing in different bodies in various degrees and modes of combination[2]. The other he called *dephlogisticated air*, by which he meant no other than exceedingly pure atmospherical air, entirely free from those heterogeneous vapours which contaminate the air we commonly breathe. It has been found by experience, that animals will live much longer in this kind of air, than in an equal quantity of common air; whence it is supposed, that the breathing of it must be much more healthy, and contribute to longevity much more than the common atmosphere. Nor are there wanting some who attribute the longevity of the antediluvians to the great purity of the atmosphere at that time; the whole mass being afterward tainted by the deluge, in such a manner, that it could never regain its former purity and salubrity. But all this is mere conjecture: and excepting the single fact, that animals live much longer in a quantity of *dephlogisticated* than of common air, there is no evidence that the former contributes more to longevity than the latter. Dr. Priestley even throws out a conjecture, that the

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[1] Even the late Dr. Goldsmith, whose History of the Earth and Animated Nature was published in 1774, appears to have had no knowledge of any difference in the kinds of air, except what was known in the time of Mr. Boyle; although the important discoveries of Hales, Priestley, Brownrigg, Black, Cavendish, &c. were then known to most philosophers.

[2] The combination of *phlogiston* with different kinds of air, and also with water, has been illustrated and evinced

by a variety of experiments by Dr. Priestley. All the kinds of air, he says, that appear to be essentially distinct from each other, are *fixed air*, *acid*, and *alkaline;* because these, and another principle, called *phlogiston*, which he has not been able to exhibit in the form of air, and which has never yet been exhibited by itself in any form, seem to constitute all the kinds of air with which he is acquainted. He has also shown how common air is depraved and rendered unfit for the purposes of respiration, combustion, &c. by mixing with the *phlogiston* discharged from the lungs of animals, from burning bodies, from calcined metals, from putrefying substances, &c. and in some cases being saturated with it, so as thereby to become phlogisticated. And as a variety of causes contributes to the release and discharge of *phlogiston* from bodies in which it is combined, and from which, by certain processes, it is disengaged, which, by uniting with the air, diminishes it, precipitates its *fixed air*, and renders it noxious, he has discovered that vegetating plants purify the air by imbibing its *phlogiston*, and that the agitation of water is also conducive to the same beneficial purpose.

use of *dephlogisticated air* might, perhaps, wear out the system much sooner than common air, in the same manner as it consumes fuel much faster than common air. The great quantity, however, even of the purest air, which is requisite to support animal life, and the expense and trouble of the most ready methods of procuring it, have hitherto prevented any fair trial from being made. Yet philosophers, considering the probability of this kind of air being salutary in many diseases, have bestowed some pains in attempting to find out methods of procuring it easily, and in a large quantity[1].

This important discovery by Dr. Priestley had been preceded by the discoveries of many other ingenious philosophers. To Lord Bacon is due the discovery of *artificial* or *factitious air*[2]; a term used by Mr. Boyle to express what the more antient chemists denominated *gas*, and which is now more generally known by the name of *fixed air*. It comprehends all those kinds of air, which are, originally, parts of some solid substance, and exist in an inelastic state; but which, by various analytical processes, are capable of being disengaged, and recovering their elasticity.

Sir Isaac Newton discovered the true *permanent air* arising from fixed bodies by heat and fermentation, and distinguishable from vapour, which is only *apparent* or *transient air*.—Dr. Hales discovered the air abounding in the Pyrmont waters, to which he attributed their spirit and briskness. He was the first, likewise, that produced the *nitrous air* from the Walton pyrites, by means of spirit of nitre; and to him our hospitals, prisons, and ships of war, owe the beneficial invention of ventilators.—Dr. Brownrigg discovered the quality of that air, which is of the *mephitic* or deadly kind; such as is found in damps, deep wells, caverns, and mines, and which is so often fatal to miners.—Dr. Black was the first who accurately investigated the chemical nature and effects of that particular kind of *factitious air*, to which he gave the name of *fixable* or *fixed air*, which adheres to all calcareous earths and alkaline salts, with different degrees of force, and which may be separated from these substances, and again combined with them.—Mr. Cavendish first discovered the *acid air*, produced from copper, by means of spirit of salt: it has a strong affinity with phlogiston; extracts it from other substances, such as inflammable spirits, expressed oils, &c. and is thereby converted into *inflammable air*. Mr. Cavendish also discovered *inflammable air*, of the nature of that found in neglected privies, common sewers, and chiefly in coal-pits, where it is called the *fire-damp*. This kind of air is surprisingly light, being only the tenth part of the weight of common air, and therefore totally different from the *mephitic*[1] or *fixed air*, which is found to be heavier. The *inflammable air* is that by which all the aërostatic machines (the Montgolfiers excepted) have been filled: it may be produced in abundance from zinc, iron, and tin, by dissolving them in the diluted vitriolic acid, or spirit of sea salt[2].

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[1] See Cavallo's Treatise on Air.

[2] Sir John Pringle's Discourse on the different Kinds of Air.

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[1] The term *mephitic* is applied to *fixed air*, to that which is *inflammable*, and to many other kinds, since they are equally noxious when breathed by animals; but it is usually appropriated to the former species of air.

[2] As *inflammable air* is specifically *lighter* than common air, it occupies the *upper* parts of subterraneous places, and is called the *fire-damp*, because it is liable to take fire, and to explode like gunpowder. The *mephitic*, or *fixed air*, on the contrary, being specifically *heavier* than common air, is found at the *bottom* of pits: it extinguishes *candles, &c.* and *kills* animals that breathe it; and, on

The *common, atmospherical,* or *heterogeneous air,* is a coalition of corpuscles of various kinds, which together form one fluid mass, wherein we live and move, and which we are continually receiving and expelling by respiration. The whole assemblage of this makes what we call the *atmosphere.* Where this air, or atmosphere, terminates, there *ether* is supposed to begin; which is distinguished from the air, by its not making any sensible refraction of the rays of light, as air does. Air, in this popular sense, is acknowledged, by Boyle, to be the most heterogeneous body in the universe. Beside the matter of light or fire, which continually flows into it from the heavenly bodies, and probably the magnetic effluvia of the earth, whatever fire can volatilize is found in the air.—In a word, a late eminent author considers the atmosphere as a large chemical vessel, wherein the matter of all the kinds of sublunary bodies is copiously floating; and thus exposed to the continual action of that immense surface the sun; whence proceed innumerable operations, sublimations, separations, compositions, digestions, fermentations, putrefactions, &c.

The component parts of our atmosphere are, indeed, so various, and of such heterogeneous natures, that they do not admit of any kind of definition or analysis, one only excepted; namely, the *electric fluid.* This, we know, pervades the

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this account, has been called the *choke-damp.* Among the most useful and important inventions of modern science, is the *safety-lamp* of Sir Humphry Davy, for preventing explosions in coal mines from *fiire-damp.* The flame of the lamp or candle is surrounded with a wire sieve, the meshes of which amount at least to 250 in an inch. This sieve completely prevents the explosion from setting fire to the gas on the outside of it, even though the most inflammable mixtures of gases, as oxygen and hydrogen be present. This contrivance is expected completely to answer the purposes of the miner, and to prevent many dreadful accidents.

whole, but appears to be much more copious in the upper than in the lower atmospherical regions. To measure the absolute quantity of this fluid, either in the atmosphere or any other substance, is impossible. All that we can know on this subject is, that the electric fluid pervades the atmosphere; that it appears, as before observed, to be more abundant in the superior than in the inferior regions; that it seems to be the immediate bond of connection between the atmosphere and the water that is suspended in it; and that, by its various operations, hail, rain, snow, lightning, and various other kinds of meteors, are occasioned.

Various attempts have been made to ascertain the height to which the atmosphere is extended all round the earth. These commenced soon after it was discovered, by means of the Torricellian tube, that air is a gravitating substance. Thus it also became known, that a column of air, whose base is a square inch, and the height that of the whole atmosphere, weighs fifteen pounds; and that the weight of air is to that of mercury as 1 to 10,800; whence it follows, that if the weight of the atmosphere be sufficient to raise a column of mercury to the height of thirty inches, the height of the homogeneous aërial column must be 10,800 times as much, and consequently, a little more than five miles high.

It was not, however, at any time supposed, that this calculation could be just; for as the air is an elastic fluid, the upper parts must expand to an immense bulk, and thus render the barometrical calculations extremely erroneous. Philosophers, therefore, have had recourse to another method, in order to determine the height of the atmosphere; namely, by a calculation of the height from which the light of the sun is refracted, so as to become visible to us *before he himself* is seen in the heavens.

By this method it was determined, that, at the height of forty-five miles, the atmosphere had no power of refraction; and, consequently, beyond that distance, was either a mere vacuum, or the next thing to it, and not to be regarded.

This theory soon became very generally received; and the height of the atmosphere was spoken of as familiarly as the height of a mountain, and reckoned to be as well ascertained as the height of the greater part of mountains. But slow, progressive, and imperfect, must be the inquiries of the philosopher into the great secrets of Nature: to the most intelligent and penetrating of human minds much must ever remain mysterious and inscrutable; mysterious and inscrutable too, perhaps, even to beings of a superior order to man in the scale of creation. To this supposed height of the atmosphere very great objections (and objections that have never yet been removed) arise from the appearance of some meteors, like large globes of fire, not unfrequently to be seen at vast heights above the earth. One of this kind appeared in March 1719, whose height Dr. Halley computed to be about 70 miles, its diameter upward of a mile and a half, and its velocity about 350 miles in a minute. There was also a remarkable one in 1783, whose distance from the earth, computed by Dr. Blagden, could not be less than 50 miles, its diameter not less than the former, and its velocity not less than 1000 miles in a minute. These meteors were not only extremely bright, but were attended with explosions. But how was flame to be supported, or sound propagated, at a height where the air must be 300,000 times rarer than that we breathe? Appearances of this kind are, indeed, with some probability, attributed to electricity; but the difficulty is not thus removed. In a word, it appears that the absolute height of the atmosphere is not yet determined. The beginning and ending of twilight indeed show, that the height at which the atmosphere begins to refract the rays of the sun is about forty-five miles. But this, perhaps, may be only the height to which the aqueous vapours are carried: for it cannot be thought an unreasonable supposition, that light is refracted only by means of the aqueous vapour contained in the atmosphere; and that, where this ceases, it is still capable of supporting the *electric* fire at least, as bright and as strong as at the surface. That it does extend much higher, is evident from the meteors already mentioned; for these are undoubtedly carried along with the atmosphere; otherwise that of 1783, which was seen for about a minute, must have been left 1000 miles to the westward, by the earth flying out below it, in its annual course round the sun.

The preceding account is perfectly compatible with the chemical theories which prevailed at the time the 'Contemplative Philosopher' was originally published: but there has been a wonderful revolution in this department of science in the course of the last twenty years; and it therefore becomes necessary to advert, though very briefly, to the opinions and principles which now occupy the place of those which are developed in this paper.

The phlogistic theory is now almost entirely abandoned; and not only a new theory, but a new and very ingenious nomenclature adopted. But we must here confine ourselves to the composition of *atmospheric air*, or, of that transparent, colourless fluid, which invests the terraqueous globe, and possesses permanent elasticity and gravity. This fluid is composed of 78 parts of *nitrogen* and 22 of *oxygen gas, in bulk*; and, in weight, of about

74 *nitrogen* and 26 oxygen; and is soluble in about 30 times its bulk in water: 100 cubic inches weigh 31 grains. On the surface of the earth it is compressed by the weight of the superincumbent atmosphere; its density therefore diminishes according to its height above the earth. It is dilatable by heat; so that at 60° of temperature, its bulk is increased about $\frac{1}{82}$ part.

The constituent principles of atmospheric air are rendered evident by the following experiment:

Quicksilver being inclosed in a proper vessel of atmospheric air, on heat being applied, the air will be diminished, and the quicksilver lose its splendour, and gradually change to a reddish powder; acquiring, at the same time, an augmentation of weight. When neither the air nor the quicksilver suffers any farther change, the separation of the principles has taken place: the one, the gas remaining in the receiver, is now unfit for supporting flame, or maintaining respiration, and is nitrogen gas; the other is absorbed by the quicksilver, while reducing to the state of an oxide, and may be extricated from it on the application of heat: when the powder, to which the quicksilver is reduced, will be restored to its metallic state, but will have lost the weight it had gained during its oxidation; this deficiency being exactly equal to the weight of the evolved gas, which is oxygen gas.

These separated gases, thus differing in their properties from each other and from atmospheric air, being again mixed, form atmospheric air of the ordinary degree of purity. It must, however, be acknowledged, that in thus forming respirable air, an aëriform fluid is obtained, differing in some trifling respects from the ordinary air of the atmosphere. M. Humboldt is of opinion, that the *composition* of atmospheric air may so vary, that the oxygen may exist in it in the proportion of from 0,23, even to 0,29.

He also supposes, that our not being able to form an aëriform fluid, perfectly similar to that of the atmosphere, does not proceed from our ignorance of the quantity or quality of the gaseous bases, but from a difference in their union: that in the atmosphere they may be considered as in a state of chemical combination, but, in the artificial, merely as a mixture.

Respiration and combustion depending on the presence of oxygen, these processes will always be affected by the proportion in which the oxygen gas exists in the air in which they are performed. The atmosphere also contains foreign matters, such as other gaseous bodies, water which it holds in solution, minute detached particles of bodies, &c. It commonly contains about 0,01; or, according to Humboldt, from 0,005 to 0,01 of carbonic acid gas.

Sir H. Davy states, that the atmospheric air differs very little in the proportion of its ingredients in different parts of the world, that of Europe, Asia, Africa, and America, being all found to contain 0,22 of oxygen in volume.

Mr. Dalton considers the general atmosphere as composed of *four* fluids principally, or *four particular atmospheres: nitrogen gas, oxygen gas, aqueous vapour, and carbonic acid gas, mechanically mixed.* These, he supposes, to be totally unconnected with each other; the particles of the one not acting on the particles of the other: but this opinion is not generally adopted.

Observation has long shown, that the air contains water; but philosophers have been divided, respecting whether the water is held in the air in a state of solution, or in the state of steam or vapour. The arguments of Mr. Dalton, however, on this subject, appear to be almost decisive in favour of this latter opinion. Water, in an exhausted receiver, is diminished even faster than in open air, its disappearance being here proved to proceed from its conversion into vapour; hence it is probable that it is converted into a state of vapour, and exists so in the open air. But the strongest proof is, that as Mr. Dalton has shown that water in the atmosphere possesses the same degree of elasticity which it does when in a state of vapour, in a state of vacuum, at the same temperature, we may conclude, safely, from these observations, that almost all the water contained in the atmosphere is in a state of vapour; and, most probably, mechanically mixed with it. A certain portion of moisture seems, indeed, to be essentially necessary to a due constitution of the air. The atmosphere, therefore, seems to consist of three elastic fluids, in the following proportion: air, 98; carbonic acid, 1; water, 1.

No. XIV.

ON THE MECHANICAL PROPERTIES AND EFFECTS OF THE AIR,

And the beneficial Ends to which it is subservient.

> Mundi pars est aër, et quidem necessaria: hic est enim qui cœlum terramque connectit. SENECA.

> Ipse aër nobiscum videt, nobiscum audit, nobiscum sonat, nihil enim eorum sine eo fieri potest. CICERO.

IN my former paper, I took a cursory review of the principal modern discoveries respecting the

ifferent kinds of air: I stated the most generally
eceived opinions, in consequence of the com-
onent parts of our atmosphere; and entered into
ome discussion of the height to which philoso-
hers have supposed it to extend. The mecha-
ical properties and effects of this wonderful
uid, with the variety of beneficial ends to which
is subservient, are subjects no less worthy of
onsideration.

The most considerable properties of air are its
uidity, weight, and elasticity.

That the air is a fluid is evident from the easy
assage through it which it affords to bodies; as in
e propagation of smells and other effluvia, and
e easy conveyance it affords to sounds. These
d similar effects prove it to be a body, whose
arts give way to any force impressed, and, in
elding, are easily moved among themselves;
hich is the definition of a fluid. Besides, it is
ertain that no degree of cold has ever yet been
een produced, natural or artificial, strong enough
deprive it of its fluidity. The cause of this
uidity of the air is attributed, by some late phi-
sophers, to the fire intermixed with it; without
hich, they imagine, the atmosphere would harden
to a solid, impenetrable mass.

The weight, or gravity, of the air was first dis-
overed by Galileo; but the pressure of the at-
osphere was observed by his disciple Torricelli,
nd the variations of it, depending on different
eights, by M. Pascal. That the air is heavy,
llows from its being a body; weight being an
ssential property of matter. But we have many
rguments to the same purpose from sense and
xperiment: thus, the hand, applied to the orifice
a vessel empty of air, soon feels the load of the
cumbent atmosphere. Glass vessels, exhausted

of their air, are easily crushed to pieces by the weight of the external air. Two small hollow segments of a sphere four inches in diameter, exactly fitting each other, being emptied of air, are pressed together by a force equal to 188 pounds, by the weight of the ambient air; and that they are kept together by the pressure of the air is evident by suspending them in an exhausted receiver, when they will separate of themselves. Moreover, if a tube, close at one end, be filled with mercury, and the other immerged in a basin of the same fluid, and thus erected, the mercury in the tube will be suspended at the height of about thirty inches above the surface of that in the basin. The reason of this suspension is, that the mercury in the tube cannot fall lower, without raising that in the basin; which being pressed upon by the weight of the incumbent atmosphere, cannot give way, unless the weight of the mercury exceeds that of the air without it. That this is the case is evident; because, if the whole apparatus be included in the receiver of an air-pump, the mercury will fall in proportion as the air is exhausted; and, on gradually letting in the air again, the mercury re-ascends to its former height. This makes what is usually called the Torricellian Experiment. The gravity of air may be further demonstrated, from the consideration that it can actually be weighed. Its weight is continually varying, according to the different degrees of heat and cold, and the concurrence of other causes. Its weight to that of water has been differently estimated by philosophers. Dr. Jurin thinks, that at a medium between heat and cold, when the barometer is thirty inches high, the proportion between the two fluids may be taken as 1 to 800; which agrees with the observation of Mr. Cavendish, the thermometer being at 50 degrees, and the barometer at 29¾ inches[1].

Air, then, being heavy and fluid, the laws of its gravitation, or pressure, may be inferred to be the same as in other fluids; and, consequently, its pressure must be as its perpendicular altitude. This is also confirmed by experiment; for, if the Torricellian tube be removed to a more elevated place, where the incumbent column of air is shorter, a proportionably shorter column of mercury is sustained. For, proceeding from the law given by observation, that the air is compressed in the ratio of the weights with which it is charged, it is proved that when the heights are in arithmetical progression, the corresponding densities are in geometrical progression; and it is manifest that these densities are in their turn proportional to the depressions of the mercury in the barometrical tube. On this principle, then, depend the structure and office of the barometer.

It follows hence, also, that the air, like all other fluids, must press equally every way. This is confirmed by observing, that soft bodies sustain this pressure without any change of figure, and brittle bodies without breaking; although the pressure upon them is equal to that of a column of mercury thirty inches high, or a column of water of thirty-two feet. It is obvious that no other cause can preserve such bodies unchanged, but the equable pressure on all sides, which resists as much as it is resisted. And hence, upon removing or diminishing the pressure on one side only, the effect of the pressure is soon perceived on the other.

From this gravity of the air, considered in connection with its fluidity, may be deduced several of its uses and effects. And first, by means of the weight and fluidity of the air, it closely invests the earth, with all the bodies upon it, and constringes and binds them down with a force amounting, according to the computation of M. Pascal, to 2232 pounds weight upon every square foot, or upward of fifteen pounds upon every square inch. Hence, it prevents, for instance, the arterial vessels of plants and animals from being too much distended by the impetus of the circulating juices, or by the elastic force of the air so plentifully contained in the blood. Thus we see, in the operation of cupping, that, upon a diminution of the pressure of the air, the parts of the body grow tumid; which necessarily alters the manner of the circulation through the capillaries, &c. The same cause prevents the juices oozing and escaping through the pores of their containing vessels.

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[1] Phil. Trans. vol. lvi. page 152.

The weight of the air likewise promotes the mixture of contiguous fluid bodies. Hence many liquids, as oils and salt, which readily and spontaneously mix in air, remain, on a removal of it, in a state of separation. The gravity of air, moreover, in some cases, determines the action of one body upon another; and to the same principle are chiefly owing our winds, which are only air put in motion by some alteration in its equilibrium.

Elasticity, the third property of the air which I have mentioned, is the power of yielding to an impression by contracting its dimensions; and, upon removing or diminishing the impressive cause, of returning to its former space or figure. This elastic force has been long accounted the distinguishing property of air; the other properties, hitherto enumerated, being common to it with other fluids[1]. This property of air was first discovered by some experiments of Lord Bacon, who, upon this principle, constructed his *vitreum calendare*, the first thermometer.

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[1] From some late experiments, however, it is more than

Of this elastic power we have numerous proofs: thus, a blown bladder being squeezed in the hand, we find the inclosed air sensibly resist; so that, upon ceasing to compress, the cavities, or impressions made in its surface, are readily expanded, and filled up again. On this property of elasticity depend the structure and office of the air-pump.

Every particle of air always exerts this endeavour to expand, and thus strives against an equal endeavour of the ambient particles; and when the resistance of the latter happens, by any means, to be weakened, it immediately diffuses into an immense extent. Hence it is, that thin glass bubbles, or bladders, filled with air, and exactly closed, being included in the exhausted receiver of an air-pump, burst, by the force of the included air. In like manner, a bladder, quite flaccid, containing the smallest quantity of air, swells in the receiver, and appears quite full. The same effect is also found, by carrying the flaccid bladder to the top of a high mountain.

The compression of the air by its own weight is surprisingly great; and it may be still further compressed by art. The utmost limits to which air, of the density which it possesses at the surface of the earth, may be compressed, have not been ascertained. Dr. Halley thinks, that no force whatever is able to reduce air into 800

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probable that the capacity of being compressed and expanded is not peculiar to air. Mr. Canton, in particular, infers, from several experiments, that spirit of wine, oil of olives, water and mercury, are not only compressible, but elastic. *See Phil. Trans. vol.* lii. *art.* 103, and *vol.* liv. *art.* 47. And it is now well known 1816) that all the gases are permanently elastic times less space than that which it naturally possesses on the surface of the earth[1]. On the contrary, M. Amontons, in the Memoirs of the French Academy, maintains, that there is no affixing any bounds to its condensation; that greater and greater weights will still reduce it into less and less compass; that it is elastic in virtue only of the fire which it contains; and that, as it is impossible ever absolutely to drive all the fire out of it, it is impossible ever to make the utmost condensation.

The dilatation of the air by virtue of its elastic force, is also found to be very surprising. Sir Isaac Newton thinks it capable of diffusing into above a million of times more space than it before possessed[2]; and Dr. Wallis suggests, that we are far from knowing the utmost of which it is capable. This immense compression and dilatation, Sir Isaac Newton observes, cannot be accounted for in any other way, than by a repelling force, with which the particles of air are endued; by virtue of which, when at liberty, they naturally fly each other; and this repelling power, he adds, is stronger and more sensible in air than in other bodies.

This elastic power of the air is the second great source of the effects of this important fluid. By means of this, it insinuates into the pores of bodies, possessing this prodigious faculty of expanding, which is so easily excited, that it must necessarily put the particles of bodies, into which it insinuates, into perpetual oscillations. Indeed, the degree of heat, and the gravity and density of the air, and consequently its elasticity and expansion, never remaining the same for the least space of iere must be an incessant vibration, or di- and contraction, in all bodies. We ob- iis reciprocation in several instances, par- r in plants, the *tracheæ* or air-vessels of lo the office of lungs; for the contained air ely contracting and expanding, as the heat s or diminishes, by turns presses the ves- d eases them again; and thus promotes nt and descent of their juices. Hence we t no vegetation or germination will proceed o. Beans, indeed, have been observed to little tumid therein; and this has led some bute that to vegetation, which was really o no other cause than the dilatation of the in them.

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[1] Philos. Trans. Abridg. vol. ii. p. 17.

[2] Optics, p. 371.

air is very instrumental in the production wth of vegetables, not only by invigorating veral juices, while in an elastic active state, by greatly contributing, in a fixed state, nion and firm connection of their several ent parts.

this elastic force it is, that the air con- in bubbles of ice, by its continual action, he ice; and thus glasses and other vessels tly crack, when their contained liquors are Thus also, entire columns of marble es cleave in the winter time, from the in- elasticity of some little bubble of included rom the same principle arise all putre- and fermentation, neither of which will l, even in the best disposed subjects,).

moreover, not only acts by its common ies of gravity and elasticity, but there are us other effects, arising from the peculiar nts of which it consists. It not only dis- nd attenuates bodies by its pressure and , but as a *chaos* containing all kind of menstrua, and consequently possessing powers for dissolving all bodies. Iron and copper readily dissolve, and become rusty in air, unless well defended with oil. Boerhaave asserts, that he had seen pillars of iron so reduced by air, that they might be crumbled to dust between the fingers. Copper is converted by the air into a substance much like the verdigris produced by vinegar. Mr. Boyle relates, that, in the southern English colonies, the great guns rust so fast, that, after lying in the air a few years, large cakes of *crocus martis* may be separated from them. Acosta adds, that in Peru the air dissolves lead, and considerably increases its weight. Yet gold is generally esteemed indissoluble by air; being never found to contract rust, though exposed to it ever so long. Stones, also, undergo the changes incident to metals.

Air, likewise, as I have observed in a former paper [1], by means of its dissolving power, accelerates evaporation and distillation. It volatilizes fixed bodies; fixes volatile bodies; and brings many quiescent bodies into action, by exciting their latent powers. In a word, in the various operations of chemistry, it is a very necessary and important agent; the result of particular processes depending on its presence or absence, on its being opened or inclosed.

Great part of the effects of air which I have enumerated, were quite unknown, as such, to the antients. They considered it, however (as appears from the mottoes at the head of this paper), as an essential part of the world, as connecting heaven and earth, and the only medium by which objects can be visible to us, and sounds become audible. 'If we consider,' says Dr. Derham,

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[1] No. XII., containing the Theory of Evaporation.

'the nature and make of the air, we find it a mass of subtile penetrating matter, fit to pervade other bodies; to penetrate into the inmost recesses of nature; to excite, animate, and spiritualize; and, in short, to be the very soul of this lower world; useful to the life, the health, the comfort, the pleasure, and the business of the whole globe.' It is essential to the existence of all creatures.

> Were once the energy of air denied,
> The heart would cease to pour its purple tide;
> The purple tide forget its wonted play,
> Nor back again pursue its curious way.

To the motion and conveyance of many animals it is also necessary.

> The feathered warbler hence, with rapid wings,
> Borne through aërial fields, exulting sings.
> With ease through all the fluid regions strays,
> And charms the skies with his melodious lays.

Various sorts of fish, too, are enabled to sustain themselves in any depth of water, and to rise or sink at pleasure, by means of a kind of *vesicula*, or air-bladder, which is found in their bodies[1].

Our atmosphere is of admirable use in the enlightening of the world, by reflecting the heavenly bodies to us, and refracting the sunbeams to our eye; so that the day is protracted throughout the whole globe, the long and dismal nights are shortened in the frigid zones, and the day approaches them sooner. The sun itself rises in appearance, when, in reality, it is absent from them, to the great comfort of those dreary regions.

It is in the atmosphere that are assembled the clouds, which assume such a variety of hues and forms, and which, as they are condensed or rarefied, retain the vapours, or return them to the earth in rain, or hail, or snow.

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[1] If this air-bladder be pricked or broken, the fish sinks to the bottom, unable either to support or raise itself up again. Flat fish, as soles, plaice, &c. which always lie grovelling at the bottom, have no air-bladder.

> The streams, their beds forsaking, upward move,
> And form again in wand'ring clouds above,
> Hence rich descending showers, hence balmy dews,
> Their plenteous sweets o'er bright'ning fields effuse;
> Hence shoots the grass, the garden smiles with flowers,
> And sportive gales steal fragrance from the bowers.

In a former Paper[1], I have given a philosophical account of the winds, which are another important part of the subject of air. To that paper I refer my readers, and shall conclude my present Essay with a poetical enumeration of their benefits:

> Of what important use to human kind,
> To what great ends subservient, is the wind!
> Where'er th' aërial active vapour flies,
> It drives the clouds, and ventilates the skies;
> Sweeps from the earth infection's noxious train,
> And swells to wholesome rage the sluggish main.
> For should the sea unagitated stand,
> Death, with huge strides, would desolate the land;
> The scorching sun, with unpropitious beam,
> Would give to grief an everlasting theme;
> And baneful vapours, lurking in the veins,
> Would fiercely burn with unabating pains.
> Nor thus alone air purifies the seas;
> O'er torrid climes it pours the healthful breeze:
> Climes, where the sun direct flings scorching day,
> Feel cooling air his sultry rage allay.
> Unceasing Goodness, with Unceasing Skill,
> Educing certain good from seeming ill;
> His guardian care extends o'er every shore,
> And blends his favours with what men deplore.
> The sable nations hence, and burning skies
> See luscious fruits in varying beauty rise;
> Spontaneous Nature laugh at Culture's toil,
> And rich Luxuriance bless the grateful soil.

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[1] See No. II.

No. XV.

ON THE INFLUENCE OF AIR ON VEGETATION, AND OF VEGETATION ON AIR.

> I cannot go
> Where Universal Love not smiles around—
> From seeming evil still educing good,
> And better thence again, and better still,
> In infinite progression. THOMSON.

I OBSERVED, in my preceding Paper, that air is very instrumental in the production and growth of vegetables. All vegetable bodies are provided with certain canals, or ducts, whereby a kind of respiration is effected in them. These canals, which are called air-vessels, are distinguished from another wise contrivance of Nature, the sap-vessels. The former answer to the *tracheæ* and lungs of animals; the latter to their lacteals and blood-vessels.

An ingenious natural philosopher, in an inquiry into the motion and cause of the air in vegetables, has shown that it enters them various ways, not only by the trunk, leaves, and other parts above ground, but at the root. For the reception as well as expulsion of the air, the pores are so very large in the trunks of some plants (as in the better sort of thick walking canes), that they are visible to a good eye without a glass; but, with a glass, the cane seems as if it were stuck full of large pin-holes, resembling the pores of the skin at the ends of the fingers and ball of the hand. In the leaves of the pine, seen through a glass, they make an elegant appearance, standing almost in rank and file, throughout the length of the leaves.

But, although the air enters in part at the trunk and other parts, especially in some plants, yet its chief admission is at the roots; as in animals, some part of it may continually pass into the body and blood by the pores of the skin; but the chief draught is at the mouth.

Air-vessels are found in the leaves of all plants, and are even discoverable in many without the help of glasses; for, upon breaking the stalk or chief fibres of a leaf, the likeness of a fine woolly substance, or, rather of curious small cobwebs, may be seen to hang at both the broken ends. This is taken notice of only in some few plants, as in *scabious*, where it is more visible; but it may be also seen, more or less, in most others, if the leaves be very tenderly broken. This wool is really a skain of air-vessels, or rather of the fibres of the air-vessels, loosed from their spiral position, and so drawn out in length[1].

Dr. Hales, in his Statical Essays, has fully proved, that air is inspired by vegetables; and he has shown, in many instances, that it freely enters into the vessels of trees, and that it is wrought, in great abundance, into their substance. The substances of vegetables, he has observed, appear, by a chemical analysis, to be composed of sulphur, volatile salt, water, and earth, which are all endued with mutually attracting powers; and also of a large portion of air, which has a wonderful power of strongly attracting in a fixed state, or of repelling in an elastic state, with a power which is superior to great compressive forces[2]. By the infinite combinations, action, and reaction of these principles, all the operations in animal and vegetable bodies are effected. These active aërial principles are very serviceable in carrying on the work of vegetation to its perfection and maturity; not only in helping, by their elasticity, to distend each ductile part, but, also, by enlivening and invigorating their sap, where, mixing with the other mutually attracting principles, they are, by gentle heat and motion, set at liberty to assimilate into the nourishment of the respective parts. The sum of the attracting powers of these mutually acting and reacting principles, is, while in this nutritive state, superior to their repelling power; by which the work of nutrition is gradually advanced by the nearer and nearer union of these principles from a less to a greater degree of consistency, till they are advanced to that viscid ductile state, whence the several parts of vegetables are formed; and are, at length, firmly compacted into hard substances, by the flying off of the watery diluting vehicle: but, when they are again disunited by the watery particles, their repelling power is thereby become superior to their attracting power, and the union of the parts of vegetables is so thoroughly dissolved, that putrefaction commences. And further, with respect to the nutrition of plants (which, in this Paper, I can only mention in a cursory way), that celebrated anatomist and natural philosopher, Dr. Hunter, has inferred, from a number of experiments, that all vegetables receive their principal nourishment from oily particles incorporated with water by

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[1] Dr. Grew, Anat. of Root, cap. iv. p. 155.

[2] The substances of which vegetables are composed, now amount to fifteen in number; but almost the whole of vegetable substances are composed of four ingredients, namely, carbon, hydrogen, oxygen, and azote. Of these, the last, namely azote, forms but a small proportion even

of those vegetable substances of which it is a constituent part, while, into many, it does not enter at all. Of caloric and light too little is known to determine, with certainty, into what substances they enter means of an alkaline salt, or absorbent earth; and to this univeral principle of oil, he adds another of great efficacy, which is the nitrous acid of the air; a principle, the existence of which is demonstrable from the method of making saltpetre in different parts of the world. It has likewise been observed, that the vegetables which have a succulent leaf, such as vetches, peas, beans, and buckwheat, draw a great part of their nourishment from the air[1].

Having thus considered the influence of air on vegetation, I shall now proceed to inquire into the influence of vegetation upon air. Dr. Hales had produced a species of air called *nitrous* air, from the Walton pyrites, by means of the spirit of nitre; but Dr. Priestley, by extending the experiment, found that the same kind of air might be procured, by means of the same kind of acid, from almost every other metallic substance; and that, when mixed with common air, an effervescence, with a turbid red colour, always ensued; and yet it made no change when either mixed with inflammable air, or tainted with the breath of animals, or the corruption of their bodies. By this criterion, he could judge of the kind as well as the degree of injury done to common air, by candles burning in it, or by the breath of people after they had left him in his study. This discovery was attended with many important consequences: it displayed the resources which Nature has in store against the bad effects of corrupted air; in a word, it evinced, that one of her grand restoratives was vegetation.

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[1] See Hales' Statics; Hunter's Georgical Essays. Water constitutes a necessary part of the food of plants, but a certain portion only is requisite, too much being equally prejudicial to them as too little. Three articles, which furnish nourishment to plants, are supplied by the atmosphere, viz. *carbonic acid*, *oxygen*, and *moisture*. Food is also absorbed, by the end of the roots, from the soil in which the plants grow; hence, the great importance of the adaptation of particular manures. This subject will be again noticed in a future Paper.

It is well known that flame cannot long subsist without a renewal of common air. The quantity of that fluid which even a small flame requires is surprising: an ordinary candle *consumes*, as it is called about a gallon of air in a minute. Now, considering the vast consumption of this vital fluid, by fires of all kinds made by man, and by volcanoes, it becomes an interesting inquiry to ascertain what change is made in the air by flame, and to discover what provision there is in nature to repair the injury to our atmosphere, of which this change is productive. It will be proper, therefore, to state by what inductions Dr. Priestley has proved his opinion.

It was natural to imagine, that, since the change of common air is necessary to vegetable as well as to animal life, both plants and animals rendered it foul in the same manner, so as to become unfit for further life and vegetation. But, when, with that expectation, the doctor had put a sprig of mint, in a growing and vigorous state, under an inverted glass jar, standing in water, he was agreeably surprised to find, that this plant not only continued to live, though in a languishing way, for two months, but that the confined air was so little corrupted by what had issued from the mint, that it would neither extinguish a candle, nor kill a small animal which he conveyed into it. The salutary nature of the effluvia of vegetables was further evinced by the observation, that air, vitiated by a candle left in it till it burnt out, was perfectly restored to its quality of supporting flame, after another sprig of mint had for some time vegetated in it. And, to show that the aromatic nature of that plant had no share in restoring this purity to the air, he observed, that vegetables of an offensive smell, and even such as had scarcely any smell at all, but were of a quick growth, proved the very best for this purpose. In a word, the virtue of growing vegetables was found to be an antidote to the baneful quality of air corrupted by animal respiration and putrefaction.

This important discovery, that sprigs of mint could thrive in a very surprising manner, even in air that had been freshly and strongly tainted with putrefaction, and that was immediately fatal to animal life, led the doctor to conclude, that plants, instead of affecting the air in the same manner with animal respiration, reverse the effects of breathing, and tend to keep the atmosphere sweet and wholesome, when it is become noxious in consequence of animals either living and breathing, or dying and putrefying in it. And from various experiments, he reasoned thus: Since the plants made use of manifestly grow and thrive in putrid air; since putrid matter is well known to afford proper nourishment for the roots of plants; and since it is likewise certain that they receive nourishment by their *leaves* as well as by their roots, it seems to be very probable, that the putrid effluvium is, in some measure, extracted from the air, by means of the leaves of plants; and, therefore that they render the remainder more fit for respiration.—Having thus ascertained the fact, that vitiated air was restored by vegetation, and considered that common air is vitiated by being combined, in various ways, with phlogiston, he was led to conjecture, that this restoration was effected by plants imbibing the phlogistic matter with which air is loaded by any of those processes that tend to injure it. And hence it is natural to conclude, that phlogiston is the *principal* pabulum or food of plants, upon which their nourishment and increase very materially depend.

Dr. Priestley's experiments on this subject were made in 1771 and 1772; and his account of them was presented to the Royal Society in 1773. He has since discovered, that *light* is necessary to enable plants to purify air; that pure air, however, is not produced by light or plants, but only by the purification of the impure air to which plants have access [1].

This subject has been since pursued by Dr. Ingenhousz, who, in 1779, published 'Experiments upon Vegetables,' discovering their great power of purifying common air in the sunshine, and of injuring it in the shade, and at night, &c.—From these experiments he has observed, that plants correct bad air, in a complete manner, in a few hours; that this wonderful operation is not owing merely to the vegetation of the plant, but to the influence of the light of the sun upon it: that plants, exposed to the light of the sun, have likewise the surprising faculty of elaborating the air which they contain, and have absorbed from the common atmosphere, into real dephlogisticated air; which they emit, principally from the under surface of their numerous leaves, into the common mass: that this operation does not commence till after the sun has appeared for some time above the horizon, and is carried on more or less briskly, in proportion to the clearness or dulness of the day; that this production of pure air diminishes toward the close of the day, and ceases entirely at sunset, except in a few plants which perform this function somewhat longer than others: that acrid, ill-scented, and even the most poisonous plants, perform this office in common with the mildest and most salutary.

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[1] Observations on Air, vol. i. p. 49, 87, vol. iv. p. 293, 305, vol. v. p. 12, 18, &c. The experiments, just related, induced Dr, Priestley, in 1776, to consider the subject with more attention. But, as in all the experiments which he made, the plants, confined in carbonic acid gas very soon died, he concluded that carbonic acid gas was not a food but a poison to plants. But, in the year 1784, Mr. Henry, of Manchester, found, by a series of experiments, that carbonic acid gas, so far from killing plants, constantly promoted their growth and vigour. The experiments also of M. Sennebier, in the year 1780, and of Saussure, jun. in 1797, have, at last, put the subject beyond the reach of dispute.

Dr. Ingenhousz has further observed, that all plants whatever emit a noxious air *in the night*; and even those which excel others in yielding the purest air in the sunshine, surpass them in the power of infecting the circumambient air in the dark, and to such a degree, that, even in a few hours, they render a large quantity of good air so noxious, that an animal confined in it loses its life in a few seconds [1]; and that, even in the daytime, plants shaded by high buildings, or growing under a dark shade of other plants, emit an air that is noxious to animals.

This intelligent philosopher has likewise observed, that the *flowers* of plants, universally, render the air highly noxious, equally by night and by day [2]:

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[1] Dr. Ingenhousz, however, has observed, that the quantity of noxious air which plants emit at night, is very inconsiderable in comparison with that of the oxygen gas which they give out during the day.

[2] A few flowers of the honeysuckle exposed even to the sun's light in the middle of the day, rendered a body of air, equal to two pints, highly noxious, in three hours. These flowers, says the doctor, like all others, after having thus rendered truly fatal a body of air equal to two pints, have lost nothing of their fragrance. The air itself, which they have poisoned, is impregnated with the same fragrant smell as the flowers themselves; so that a person shut up in a small and close room, containing a large quantity of

that their roots, detached from the ground, possess the same property, some few excepted: that fruits, in general, even the most delicious, have this deleterious quality (but principally in the dark) to such an astonishing degree, as to endanger the life of a person who should happen to be shut up in a small and close room, where a great quantity of them is stored up: and lastly, that the light of the sun, singly, has not the power of purifying any quantity of air exposed to it, without the concurrence of the plants.

The experiments of Dr. Ingenhousz, united with those of subsequent philosophers, indubitably prove that the action of vegetables upon air, at least in the day, is directly opposite to that of animals. The latter inspire the common atmospherical air into their lungs, and then emit it thence, loaded with a foreign and noxious principle. Vegetables, on the contrary, absorbing carbonic acid gas, decompose it, give out the oxygen, and retain the carbon which forms a part of their nourishment; thus affording to man and animals that vital air upon which their existence depends.

It has been already said, that neither candles will burn, nor animals live, beyond a certain time, in a given quantity of air; yet the cause of such speedy extinction and death was unknown, and no method was again found out for rendering that empoisoned air fit for respiration, until the experiments and discoveries of the eminent philosophers whom I have mentioned last. Some provision there must be for this purpose, as well as for that of supporting flame; for, without such a provision, the whole atmosphere would in time become unfit for animal

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the most fragrant flowers, might lose his life by this most treacherous of all poisons. He has heard of more than one instance of sudden deaths, which were too probably occasioned by this *hitherto* unsuspected cause.

life, and the race of men, as well as of beasts, would die of a pestilential distemper. And yet we have reason to believe, that the air is not less proper for respiration in our days, than it was above 2000 years ago, which is as far as we can go back in natural history.

For this important end, therefore, Dr. Priestley has suggested to the divine, as well as to the philosopher, two grand resources of Nature—the vegetable creation already mentioned, and the sea and other great bodies of water.

With respect to the last, Dr. Priestley has observed, that both the air corrupted by the breath of animals, and that vitiated by other putrid matter, was sweetened, in a great measure, by the septic part infusing itself into water. He concluded, therefore, that the ocean, and the great lakes and rivers, that cover so large a proportion of the globe, must be highly useful by absorbing what is putrid, for the further purification of the atmosphere; thus bestowing what would be noxious to man, and other animals, upon the formation of marine and other aquatic plants, or upon other purposes yet unknown.

In fine, we are assured from these great discoveries, that no vegetable grows in vain: but that, from the oak of the forest to the grass of the field, every individual plant is serviceable to mankind: if not always distinguished by some private virtue, yet making a part of the whole which cleanses and purifies our atmosphere. In this the fragrant rose and deadly nightshade alike co-operate. Nor are the herbage and woods that flourish in the most remote and unpeopled regions unprofitable to us, nor we to them, considering how constantly the winds convey to them our vitiated air, for our relief, and for their nourishment. And if ever these *salutary* gales rise to storms and hurricanes, let as still trace and revere the ways of a beneficent Being, who, not fortuitously, but with design; not in wrath, but in mercy; thus shakes the waters and the air together, to bury in the deep those putrid and pestilential effluvia, which the vegetables upon the face of the earth had been insufficient to consume.

Let no presuming impious railer tax
Creative Wisdom, as if aught was formed
In vain, or not for admirable ends.—
Lives there the man, whose universal eye
Has swept at once the unbounded scheme of things;
Marked their dependence so, and firm accord,
As with unfalt'ring accent to conclude
That *this* availeth nought?—
Till such exist, let zealous praise ascend,
And hymns of holy wonder, to that Power,
Whose wisdom shines as lovely on our minds,
As on our smiling eyes his servant-sun. THOMSON.

No. XVI.

ON THE NATURE AND PROPERTIES OF WATER.

Nymphs! your bright squadrons watch with chemic eyes
The cold-elastic vapours, as they rise;
With playful force arrest them as they pass,
And to *pure* air betroth the *flaming* gas,
Round their translucent forms at once they fling
Their rapturous arms, with silver bosoms cling;
In fleecy clouds their fluttering wings extend,
Or from the skies in lucid showers descend;
Whence rills and rivers owe their secret birth,
And ocean's hundred arms infold the earth.
BOTANIC GARDEN.

IT was the opinion of Thales, and other antient philosophers, that water was the original of all things. Hence Pindar, when he would illustrate the superiority of the Olympic games over all others, sets out with observing, that they hold the same rank as water does among the elements, and gold among the gifts of Fortune.

Chief of Nature's works divine,
  Water claims the highest praise,
Richest offspring of the mine,
  Gold like fire, whose flashing rays
From afar conspicuous gleam
  Through the night's involving cloud,
First in lustre and esteem,
  Decks the treasures of the proud:
So among the lists of fame
  Pisa's honoured game excel;
Then to Pisa's glorious name
  Tune, O Muse, thy sounding shell.
WEST'S PINDAR.

Nor was this opinion confined to remote antiquity. Van Helmont, and others among the moderns, have likewise maintained, that water is the elemental matter, or stamen, of all things, and is alone sufficient for the production of all the visible creation. And Sir Isaac Newton thus expresses himself on this subject: 'All birds, beasts, and fishes, insects, trees, and vegetables, with their several parts, do grow out of water, and watery tinctures and salts; and, by putrefaction, they all return again to watery substances.'

The same great philosopher defines water to be a fluid salt, volatile, and void of taste. But Boerhaave sets aside this definition; 'for water (he observes) is a menstruum, or dissolvent of salts and saline bodies, which does not agree with the notion of its being a salt itself: for we do not know of any one salt that dissolves another.'—By some late experiments of Lavoisier, Watt, Cavendish, Priestley, and Kirwan, it appears, that water consists of *dephlogisticated* air, and inflammable air or phlogiston intimately united; or, as Mr. Watt conceives, of dephlogisticated air and phlogiston, deprived of part of their latent heat. This doctrine is alluded to in my motto [1].

In contemplating Nature, we shall often find the same substances possessed of contrary qualities, and producing opposite effects. Air which liquefies one substance, dries up another. That fire which is seen to burn up the desert, is often found, in other places, to assist the luxuriance of vegetation; and water which, next to fire, is the most fluid substance upon earth, gives to all other bodies their firmness and durability: so that every element seems to be a powerful servant, capable of either good or ill, and only awaiting external direction, to become the friend or enemy of mankind. These opposite qualities, in water in particular, have not failed to excite the admiration and inquiry of the curious.

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[1] Until very lately, water was esteemed a simple element, nor are all the most celebrated chemists of Europe yet converts to the new opinion of its decomposition. M. Lavoisier and others of the French school have most ingeniously endeavoured to show that water consists of pure air, called by them oxygen, and of inflammable air, called hydrogen, with as much of the matter of heat, or caloric, as is necessary to preserve them in the form of gas. Gas is distinguished from steam by its preserving its elasticity under the pressure of the atmosphere, and in the greatest degrees of cold yet known. The history of the progress of this great discovery is detailed in the Memoirs of the Royal Academy for 1781, and the experimental proofs of it are delivered in Lavoisier's Elements of Chemistry. The results of which are, that water consists of eighty-five parts by weight of oxygen, and fifteen parts by weight of hydrogen, with a sufficient quantity of caloric. Not only numerous chemical phenomena, but many atmospherical and vegetable facts, receive clear and beautiful elucidation from this important analysis. In the atmosphere, inflammable air is probably perpetually uniting with vital air, and producing moisture which descends in dews and showers, while the growth of vegetables by the assistance of light is perpetually again decomposing the water they imbibe from the earth; and while they retain the inflammable air for the formation of oils, wax, honey, resin, &c. they give up the vital air to replenish the atmosphere. *Darwin's Botanic Garden*, part i, *page 132.*

That water is the most penetrating body next to fire, and the most difficult to confine, has been proved by various experiments. A vessel through which water cannot pass, may refrain any thing. Nor is it any objection, that syrups and oils will sometimes pass through bodies which hold water; this not being owing to the greater subtilty and penetrability of their particles, but to the resin with which the wood of such vessels abounds, and to which oils and syrups are as menstruums; so that, dissolving the resin, they make their way through the spaces left thereby. But water, on the contrary, not acting on resins, is retained in the same vessels. And yet it gradually makes its way, even through all woods, and is retainable only in glass and metals. It was found, moreover, by an experiment at Florence, that when shut up in a spherical vessel of gold, and then pressed with great force, it makes its way through the pores even of the gold: so that the most solid body is permeable to water, under certain circumstances. It is even found more fluid than air; a body being reputed more fluid than another, when its part will find way through smaller pores. Now air, it is well known, will not pass through leather; as is evident in the case of an exhausted receiver covered therewith; but water will pass through leather with ease. Air, likewise, may be retained in a bladder, which water oozes through. It is found, indeed, that water will pass through pores ten times smaller than air will.—But here it must be observed, that M. Homberg accounts, for this passage of water through *the narrow* pores of animal substances, which will not admit the air, on the principle of its moistening and dissolving the glutinous matter of the fine fibres of the membranes, and rendering them more pliable and distractile; which is what the air, for want of a wetting quality, cannot do. As a proof of this doctrine, he filled a bladder, compressed it with a stone, and found no air to come out; but placing the bladder, thus compressed, in water, the air easily escaped.

Hence water, from its penetrative power, may be supposed to enter into the composition of all bodies, vegetable, animal, and fossil; with this particular circumstance, that it can always be separated, by a gentle heat, from those substances with which it has been united. Fire, indeed, will penetrate more than water; but it is not so easily to be separated again.

This property of water, joined with its smoothness and lubricity, fits it to serve as a vehicle for the commodious and easy conveyance of the nutritious matter of all bodies. Being so fluid, and passing and repassing so readily, it never stops up the pores, and leaves room for the following water to bring on a new supply of nutritious matter.

The same water, however, so little cohesive as it is, and so easily to be separated from most bodies, will cohere firmly with some others, and bind them together in the most solid masses; though it appears wonderful, that water, which may be shown an almost universal dissolvent, should, nevertheless, be a great coagulator.

Water, mixed up with earth and ashes, gives them the utmost firmness and fixity. The ashes, for instance, of an animal, incorporated with pure water into a paste, and baked with a vehement fire, become a coppel; which is a body remarkable for this, that it will bear the utmost effort of a *refiner's furnace*. *It is, in* reality, upon the glutinous nature of water only that our houses stand; for, take the water out of wood, and it becomes ashes; or out of tiles, and they become dust.

A little clay, dried in the sun, becomes a powder, which, mixed with water, sticks together again, and may be fashioned to any form; and this, dried again by a gentle fire, or in the sun, and then baked in a potter's oven by an intense fire, becomes little other than a stone. The Chinese earth, of which our porcelain vessels are made, which hold all liquors, and even melted lead itself, is diluted and wrought up with water. In fine, all the stability and firmness visible in the universe have been ascribed, by some writers, to water alone. Thus, they say, stone would be an incoherent sand, did not water bind it together; and thus, again, of a fat, gravelly earth, wrought up with water, and baked, or burnt, we make bricks, tiles, and earthen vessels, of such exceeding hardness and closeness, that water itself cannot pass through them. And these bodies, although to appearance perfectly dry, and destitute of water, yet being pulverized, and put into a retort, and distilled, yield an incredible quantity of water. The same, it is said, holds of metals; for the parings or filings of lead, tin, antimony, &c. yield water plentifully, by distillation; and the hardest stones, sea-salt, nitre, vitriol, sulphur, &c. are found to consist chiefly of water, into which they resolve by the force of fire. The lapis calcareus, or limestone, being exposed to the fire, affords a prodigious quantity of pure water; and the more of this water is extracted, the more friable does it become, till, at length, it commences a dry calx, or lime, wherein, in lieu of the water so expelled, the fire enters, in the course of calcination; and this is expelled again, in its turn, by pouring on *cold* water. Yet the same water and calx, temered together, produce a mass, scarcely inferior, n point of solidity, to the primitive limestone.—Many, if not most, of the effects here ascribed to water, in uniting and consolidating the parts of various bodies, have been attributed, by modern chemists and philosophers, to the gas, or fixable air, which enters into their composition; which escapes when they are dissolved, and which is capable, in certain circumstances, of being again restored to them.

Although water be defined a *fluid*, it has been a controverted point among philosophers, whether fluidity be its natural state, or the effect of violence. We sometimes find it appear in a fluid and sometimes in a solid form; and as the former, in our warmer climate, is the more common, we conclude it to be the proper one, and ascribe the other to the extraneous action of cold. Boerhaave, however, asserts the contrary, and maintains water to be naturally of the crystalline kind; since, wherever a certain degree of fire is wanting to keep it in fusion, it readily grows into a hard substance, under the denomination of ice. Boyle is much of the same opinion. Ice, he observes, is commonly reputed to be water brought into a preternatural state by cold; but with regard to the nature of things, and setting aside our arbitrary ideas, it might be as justly said, that water is ice preternaturally thawed by heat. If it be urged, that ice left to itself, will, upon the removal of the freezing agents, return to water, it may be answered, that, not to mention the snow and ice which lie, during the whole summer, on the Alps, and other high mountains, even in the torrid zone, we have been assured, that, in some parts of Siberia, the surface of the ground continues more months in the year frozen by the natural temperature of the climate, than thawed by the heat of the sun; and, a little below the surface of the ground, the water that may happen to be lodged in the cavities there continues in a state of ice all the year round: so that, in the heat of summer, when the fields are covered with corn, if you dig a foot or two deep, you will find ice, and a frozen soil.

Water, if it could be had clear and pure, Boerhaave observes, would have all the requisites of an element, and be as simple as fire; but no expedient has hitherto been discovered for procuring it so pure. Rain-water, which seems the purest of all those we know of, is replete with numberless exhalations of all kinds, which it imbibes from the air; so that, if filtered and distilled a thousand times, feces still remain. The rain-water, moreover, gathered from the roofs of houses, is a lixivium of the salt of tiles, slate, and the like, impregnated with the dungs and feces of the animals, birds, &c. deposited thereon, and the exhalations of numerous other things. It may be added, that all the rain-water gathered in cities must, at least, be saturated with the smoke of a thousand chimnies, and the various effluvia of a number of persons, &c. Besides this, fire is contained in all water; as appears from its fluidity, which is owing to fire alone.

As what is in the air necessarily mixes itself with water, it hence appears impossible to have such a thing as pure water. If you percolate it through sand, or squeeze it through pumice, or pass it through any other body of the same kind, you will always have salt remaining. Even distillation cannot render it pure; for it leaves air therein, which necessarily abounds in corpuscles of all sorts.

The water that flows within, or upon the surface of the earth, contains various earthy, saline, metallic, vegetable, or animal particles, according to the substances over or through which they pass.

The purest of all waters we can any way obtain, is that distilled from snow, gathered in a clear, still, pinching night, in some very high place; taking none but the outer or superficial part of it. But a number of repeated distillations, the greatest part of the earth, and other feces, may be separated from this: and this is what we must be contented to call pure water. In a word, it is the opinion of Boerhaave, that no person ever saw a drop of pure water: that the utmost of its purity known, amounts only to its being free from this or that sort of matter; that it can never, for instance, be quite deprived of salt; since air will always accompany it, and air always contains salts.

Many of the most eminent chemists have made experiments, in order to ascertain the conversion of water into earth. Boyle relates, that an ounce of water, distilled carefully in glass vessels two hundred times, yielded six drams of a white, light, insipid earth, fixed in the air, and indissoluble in water. Hence he concludes, that the whole water, by further prosecuting the operation, might be converted into earth. Godfrey, and others, concur in this opinion; but Boerhaave (who attributes the earth obtained by Boyle to the dust floating in the air, and to the instruments employed in the operation) is supported by Macquer, and others, in maintaining, that pure water is unalterable, and incapable of being decomposed; so that, whatever be the substances with which it is combined, when separated from these and sufficiently purified (and also when distilled singly, or mixed with other substances), its nature and essential properties still remain unchanged.

Water seems to be diffused every where, and to be present in all space, where there is matter. There are few bodies in nature that will not yield water; and it is even asserted, that fire itself is not without it. Among other remarkable circumstances, it has been observed, that bones dead and dried twenty-five years, and thus become almost as hard as iron, have yet, by distillation, afforded half their weight of water.

Water is a very volatile body; it is entirely reduced into vapour, and dissipated, when exposed to the fire and unconfined. Heated in an open vessel, it has been observed to acquire no more than a certain determinate degree of heat, how intense soever the fire to which it is exposed; and this greatest degree of heat is that which it has at the moment before it begins to boil.

It was formerly imagined, that water was incompressible, and therefore non-elastic; an opinion, founded on the famous Florentine experiment already mentioned, as proving its penetrative power. But the validity of the inferences drawn from this experiment have been justly questioned; Mr. Canton having proved, by very accurate experiments, that water actually is compressed by the weight of the atmosphere.

But, not to be too diffusive on this subject, I shall endeavour to state concisely the nature of the component particles of water, and then its various uses.

First: the particles of water are, as to our senses, infinitely small, whence their penetrative power. 2. Very smooth and slippery, or void of any sensible asperities. 3. Extremely solid. 4. Perfectly transparent, and as such invisible[1]. 5. If water be considered as consisting of spherical

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[1] Pure water, inclosed in a vessel hermetically sealed, projects no shadow, so that the eye cannot discover whether the vessel have water in it or not; besides, the crystals of salts, when the water is separated from them, lose their transparency.

ıbical particles, hollow within-side, and of a
texture, here will be enough to account for
lifficulty of compressing it, and also for its
ʒ light, fluid, and volatile; its firmness and
arity will make it resist sufficiently; and its
ity renders it light enough, &c. And the lit-
ontact between spherules (if, indeed, they
ı at all) will account for the weakness of its
ion. 6. Water is the most insipid of all bo-
the taste we sometimes observe therein not
g from the mere water, but from salt, vitriol,
her bodies mixed with it. And, lastly, it is
ctly inodorous, and void of the least smell.

ıe uses of water are infinite; in food, medi-
agriculture, navigation, and many of the
As a food, it is one of the most universal
s in the world; and, if we may credit many
r latest and most judicious physicians, it is
ne of the best. As a medicine, it is found
ally a powerful febrifuge; and excellent
st colds, coughs, the stone, scurvy, &c. Ex-
lly, its effects are not less considerable. In
lture and gardening, water is allowed abso-
necessary to vegetation. Many naturalists
even maintained it to be the vegetable mat-
r the only proper food of plants; but Dr.
dward has overturned that opinion, and en-
ured to show, that the office of water in ve-
ion is only to be a vehicle to a terrestrial mat-
f which vegetables are formed, and that it
not itself make any addition to them. Water
he utmost use in chemistry, being one of the
instruments by which all its operations are
rmed; and it is of the greatest service in
of the mechanical arts and ordinary occa-
of life.

No. XVII.

ON FOUNTAINS AND RIVERS.

Addidit et fontes, immensaque stagna lacusque;
Fluminaque obliquis cinxit declivia ripis:
Quæ diversa locis partim sorbentur ab ipsâ;
In mare perveniunt partim, campoque recepta
Liberioris aquæ, pro ripis littora pulsant. OVID.

Fountains and ponds he adds, and lakes immense;
Descending streams the winding borders fence,
This, deep absorbed, the darksome cavern laves;
These to the ocean roll their azure waves;
There, uncontrolled, they meet the roaring tide,
And dash, for verdant banks, the hoar cliff's side.

WHAT a delightful ornament to a countr the winding course of a river! How much m exquisitely enchanting does it render the m beautiful landscape! And of what an unspeak variety of benefits is it productive to the count through which it flows! Hence rivers, in all t diversities of scenery, ever appear a favou theme in poetical composition. Homer sel mentions the country of any of his great per ages, without introducing the principal river waters it by some distinguishing characteri The Eridanus of the ancients (the modern Po) been celebrated by Virgil, Claudian, and Luc Denham and Pope have immortalized the Tham and even the rivers in savage climes, that roll t immensity of waters through vast solitary wi have neither been neglected nor unsung by our scriptive poets.

When we contemplate a river at its foun head, and perceive that, at first, it is nothing n than a little vein of water, oozing from some upon a bed of clay or sand, we naturally inquire into the causes of this phenomenon, or, in other words, into the origin of fountains and rivers. Concerning this subject natural philosophers have formed very different conjectures. Those, who imagine that fountains owe their origin to waters brought from the sea by subterranean ducts, give a tolerable account how they lose their saltness by percolation, as they pass through the earth: but they find great difficulty in explaining by what power the water rises above the level of the sea to the tops of mountains, where springs generally abound; it being contrary to the laws of hydrostatics, that a fluid should rise in a tube above the level of its surface. And Sir Richard Blackmore, in the first book of his poem entitled Creation, while he seems to admit this theory, thus inquires;

> Tell by what paths, what subterranean ways,
> Back to the fountain's head the sea conveys
> The refluent rivers, and the land repays?
> Tell what superior, what controlling cause
> Makes waters, in contempt of Nature's laws,
> Climb up, and gain th' aspiring mountain height,
> Swift and forgetful of their native weight?
> What happy works, what engines under ground,
> What instruments of curious art are found,
> Which must with everlasting labour play,
> Back to their springs the rivers to convey,
> And keep their correspondence with the sea?

Des Cartes, in order to solve this difficulty, imagined, that after the water is become fresh by percolation, it is raised out of the caverns of the earth in vapours toward its surface; where meeting with rocks near the tops of mountains, in the form of arches or vaults, it adheres to them, and runs down their sides (like water in an alembic), till it meets with proper receptacles, from which it supplies the fountains. Varenius and others imagine, that water may rise through the pores of the earth, as through capillary tubes, by attraction. They illustrate the rise of sea-water up into mountains and hills, by putting a little heap of sand or ashes, a loaf of bread, or the like, into a basin of water; in which case the sand, &c. will represent the dry land, or an island, and the basin of water the sea around it. Here the water in the basin will rise to or near the top of the heap, in the same manner, and from the same principle, as the waters of the sea, lakes, &c. rise in the hills. The principle of the ascent in both is accordingly supposed to be the same with that of the ascent of liquids in capillary tubes, or between contiguous planes, or in a tube filled with ashes; all which are generally accounted for from the doctrine of attraction. But to each of these theories there are insurmountable objections: and Thomson, whose philosophical descriptions are frequently unexceptionable, has particularly endeavoured to refute the latter.

Some sages say, that where the numerons wave
For ever lashes the surrounding shores,
Drilled through the sandy stratum, every way,
The waters with the sandy stratum rise;
Amid whose angles infinitely strained,
They joyful leave their jaggy salts behind,
And clear and sweeten as they soak along.
Nor stops the restless fluid mounting still,
Tho' oft amid th' irriguous vale of springs;
But to the mountain courted by the sand,
That leads it darkling on in faithful maze,
Far from the parent-main, it boils again
Fresh into day; and all the glittering hill
Is bright with spouting rills. But hence this vain
Amusive dream! Why should the waters love
To take so far a journey to the hills,
When the sweet vallies offer to their toil
Inviting quiet, and a nearer bed?
Or if, by blind ambition led astray,
They must aspire, why should they sudden stop
Among the broken mountain's rushy dells,

And, ere they gain its highest peak, desert
Th' attractive sand that charmed their course so long?
Besides, the hard agglomerating salts,
The spoil of ages would impervious choak
Their secret channels; or, by slow degrees,
High as the hills protrude the swelling vales:
Old Ocean too, sucked through the porous globe,
Had long, ere now, forsook his horrid bed,
And brought Deucalion's watery times again.

Another opinion, which has been very generally received, is that of Mariotte, in his Traité du Mouvement des Eaux, who attributes the rise of springs to the rains and melted snow. According to him, the rain-water which falls upon the hills and mountains, penetrating the surface, meets with clay or rocks contiguous to each other. It runs along these, without being able to penetrate them, till, having arrived at the bottom of the mountain, or at a considerable distance from the top, it breaks out of the ground, and thus forms the springs.—But, in order to examine this opinion, M. M. Perrault and de la Hire endeavoured, by an experiment, to estimate the quantity of rain and snow that fell in a year; and the result of their inquiries was that the quantity which fell was not sufficient to supply the rivers; for that those of England, Ireland, and Spain, discharge a greater quantity of water annually, than the rain, according to their experiment, was able to supply. They likewise found, that the quantity of water raised in vapour, one year with another, was thirteen times more than falls in rain; which was a plain indication, that the water of fountains cannot be entirely supplied by rain or melted snow.

Dr. Halley's system is that which seems to have given the most general satisfaction. He attributes the origin of springs to vapours raised by the action of the sun, as well as by the agitation of the winds, from seas, lakes, &c. He made several experiments in order to show, that vapour is a sufficient fund to supply all our springs, rivers, &c. For instance, in order to find the quantity of water which the Mediterranean receives, he allowed the most considerable rivers that run into it, namely, the Iberus, Rhone, Tyber, Po, Danube, Neister, Boristhenes, Tanais, and Nile, each to furnish ten times as much water as the Thames; not that any of them are in reality so great, but thus to allow for the small rivulets. Now the Thames is found, by calculation, to evacuate 203,000,000 tuns of water daily. All the other nine rivers, therefore, will only evacuate 1827 millions of tuns in a day; which is little more than a third of what he had demonstrated, by his preceding experiments, to be raised in that time in vapour. And hence, this great man has discovered a source, abundantly sufficient for the supply of fountains.

Dr. Halley next proceeds to account for this theory on the principles of evaporation. He considers that if an atom of water was expanded into a bubble, so as to be ten times as big in diameter as when it was in water, that atom would become specifically lighter than the air; and therefore would rise, so long as the warmth, which first separated it from the surface of the water, should continue to distend it to the same degree; and, consequently, that vapours may be raised from the sea in that manner, till they arrive at a certain height in the atmosphere, in which they find air of equal specific gravity with themselves. Here they will float, till, being condensed by cold, they become specifically heavier than the air, and fall down in dew; or, being driven by the winds against the sides of mountains (many of which far exceed the usual height to which vapours would of themselves ascend), are compelled by the stream of air to mount up with it to their summits. There, being condensed into water, they presently precipitate, and, oozing down by the crannies of the stones, part of them enters into the caverns of the hills. These being once filled, all the overplus of water that comes thither runs over by the lowest place, and, breaking out by the sides of the hills, forms single springs. Many of these running down by the vallies, between the ridges of the hills, and coming to unite, form little rivulets or brooks. Many of these again meeting in one common valley, and, by gaining the plain ground, having grown less rapid, become a river: and many of these uniting, form such prodigious streams of water as the Volga, the Danube, and the Rhone.

Thus, one part of the vapours that are blown on the land is returned by the rivers to the sea whence it came. Another part falls into the sea before it can reach the land; which is the reason why the rivers do not return so much water into the Mediterranean as is raised by vapour. A third part falls upon the low grounds, and furnishes the pabulum or nutriment of plants. But the circulation does not end even here; for it is again exhaled into vapour by the action of the sun, and returned to the great world of waters whence it first arose.

Thomson, in his poetical account of the origin of fountains, seems to have blended the theories of Mariotte and Halley:

> Where lurk the dark eternal springs,
> That, like creating Nature, lie concealed
> From mortal eye, yet with their lavish stores
> Refresh the globe, and all its joyous tribes?

O thou pervading Genius, given to man,
To trace the secrets of the dark abyss,
O, lay the mountains bare! and wide display
Their hidden structure to th' astonished view!

* * * * * * * *

Amazing scene! Behold! the glooms disclose;
I see the rivers in their infant-beds!
Deep, deep I hear them, lab'ring to get free!
I see the leaning strata, artful ranged;
The gaping fissures to receive the rains,
The melting snows, and ever-dripping fogs.
Strowed bibulous above I see the sands,
The pebbly gravel next, the layers then
Of mingled moulds, of more retentive earths,
The guttered rocks, and mazy-running clefts;
That, while the stealing moisture they transmit,
Retard its motion, and forbid its waste.
Beneath th' incessant weeping of these drains,
I see the rocky syphons stretched immense,
The mighty reservoirs of hardened chalk,
Or stiff-compacted clay, capacious formed.
O'erflowing thence, the congregated stores,
The crystal treasures of the liquid world,
Through the stirred sands a bubbling passage burst;
And welling out, around the middle steep,
Or from the bottoms of the bosomed hills,
In pure effusion flow. United, thus,
Th' exhaling sun, the vapour-burdened air,
The gelid mountains, that to rain condensed
These vapours in continual current draw,
And send them, o'er the fair-divided earth,
In bounteous rivers to the deep again,
A social commerce hold, and firm support
The full-adjusted harmony of things.

But although the theory of Dr. Halley appears thus beautiful, and seems indeed to be most genetally adopted, it must still be confessed to be encumbered with great difficulties. The perpetuity of many springs, which always yield the same quantity when the least rain or vapour is afforded, as well as when the greatest, is a strong objection to both. Dr. Derham mentions a spring at Upminster, in Essex, which he could never perceive by his eye to be diminished, in the greatest droughts, even when all the ponds in the country, as well as an adjoining brook, had been dry for several months together; nor ever to be increased in the most rainy seasons, excepting, perhaps, for a few hours, or, at most, for a day, from sudden and violent rains. He, therefore, justly concludes, that had this spring its origin from rain or vapour, there would be found an increase or decrease of its water, corresponding to the causes of its production. Another important thing must not be forgotten of this Upminster spring, and of thousands of others; namely, that it breaks out of so inconsiderable an eminence, as can have no more influence on the condensation of the vapours, or stopping the clouds, than the lower lands about it.—Ricciolus, and other naturalists, deny that rain or dew can be a sufficient supply for the great perennial springs, and much less for the constant current of the larger rivers. The Volga alone, they say, pours forth as much water in a year's time into the Caspian sea, as would suffice to drown the surface of the whole earth. They affirm, moreover, that this river, and the other rivers on the several parts of the globe, upon a very moderate calculation, discharge at least as much water into the sea, as falls upon the surface of the whole earth in rains, mists, dews, snows, &c. in a like space of time.—Nor, upon Dr. Halley's theory, can they account for the origin of hot and salt springs, nor of those springs which rise in places where there falls little or no rain.—Hence they have recourse, and particularly Dr. Plot, in his 'Tentamen de Origine Fontium,' to certain subterranean communications between the sea and the sources of fountains, rivers, and the larger springs, by which these are supplied; and they assert that there are certain charybdes, or apertures, which swallow the sea for this purpose[*].

Whither then shall we wander in search of certainty, when the most learned disagree; when long and laborious calculations are adduced by all sides, that seem only to involve the subject in obscurity? But, whatever be the uncertainty of philosophers on this subject, the unspeakable advantages which we derive from fountains and rivers are obvious to the most uninformed. Omniscience alone can comprehend all the operations of Omnipotence. Nor is it only in the great work of our Redemption, but in the astonishing mysteries of Nature, that we may exclaim with the Apostle Paul: '*O the depth of the riches both of the wisdom and knowledge of God! How unsearchable are his judgments, and his ways past finding out!....Of him, and through him, and to him, are all things: to whom be glory for ever, Amen.*'

I might enlarge this discussion with a variety of interesting particulars relative to fountains and rivers. But I shall wave these, for the present, in order to lay before my readers a poetical description, never published before, of the progress of a river from its source to the sea. As it is intended to be descriptive only of scenes that may be supposed to be familiar to an English eye, it takes no notice of the thundering cataracts, golden sands, and other objects of savage climes; nor will it be considered, perhaps, as defective, in not containing a single allusion to river-gods and water-nymphs, or to any of the trite machinery of antient fiction.

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[*] The most accurate experiments on evaporation are those of Mr. Dalton. For an account of them, with their application to the present subject, the reader may consult the 'Manchester Memoirs;' or, for a succinct view (though too extended for insertion here), the article *Evaporation*, in that valuable work the PANTOLOGIA.

Behold the riv'let, from its parent-source,
Steal thro' the thicket with unheeded course;
Of future greatness yet unconscious stray,
Like infant princes, in their infant play;
O'er its rough bed in lulling murmurs flow,
Or thro' the breezy sedge meand'ring slow.
And now in waves, impelling-soft, it roves
Thro' sunny banks, or deep involving groves;
From sister-streams receives enriching aid,
And wonders at the progress it has made.
Now tufty isles the doubtful stream divide,
The sacred haunts of Cygnus' plumy pride:
O'er the clear crystal hangs the woody scene,
The weeping willow, or bright ever-green.
The trembling branches, all inverted, seem
To point to other skies below the stream.
The sun reflected, gilds th' illusive deep,
Or shadowing winds the mantling surface sweep.
Here thick'ning grass invites the mower's scythe,
The busy groups of men and maidens blithe;
Here the shorn meadow brightens to the eye;
The scattered herds lie ruminating nigh:
Each rising charm the bounteous stream bestows,
The grass that thickens, and the flower that blows.
And while the vale the humid wealth imbibes,
The fost'ring wave sustains the finny tribes;
The carp, with golden scales, in wanton play;
The trout, in crimson-speckled glory gay;
The red-finned roach, the silver coated eel,
The pike, whose haunt the twisted roots conceal;
The healing tench, the gudgeon, pearch, and bream,
And all the sportive natives of the stream.
The vig'rous stream now drives the busy mill,
And now disdains the little name of *rill*.
The clust'ring cots adorn its flow'ry sides,
Where blest Content, with rosy Health, abides.
Or here the villa's simple charms invite,
Where rural ease and elegance unite.
There, gaudy Art her cumb'rous pomp displays,
Where gay Caprice bedecks the verdant maze;
The palace, column, temple, statue, rears;
While Nature fashionably drest appears,
And now the bridge, by busy mortals trod,
High over-arches the ambitious flood.
Now crowded cities, lofty turrets rise,
And smoking columns mingle with the skies;

Where the rash youth their limbs exulting lave;
Where oars innum'rous beat th' astonished wave.
On the proud surface swells th' impatient sail,
And gladdened coasts the welcome streamers hail.
Expanding still the rough'ning waters glide,
In haste to mingle with the briny tide[1];
Till sea-like grown, they now disdain all bound,
And rushing to the deep, resistless pour around.
And thus the youth whom Education leads
Thro' Wisdom's paths, and Virtue's peaceful meads,
Tho' in his tender years he thoughtless play,
Nor think his flow'ry spring will pass away;
Tho' trifling scenes and trifling toys amuse,
Yet still his course, progressive, he pursues.
Fresh streams of knowledge all their stores impart,
Wealth to his mind, and goodness to his heart;
Aspiring Faith and Piety, which here
Teach whom to love, and whom alone to fear.
Rich fruits of virtue God himself supplies,
And Pleasure's flow'rs in rich succession rise;
For Virtue ever kindred Pleasure meets,
And bright Example sheds her fragrant sweets:
Th' inspiring force of excellence confest,
Blest in himself he renders others blest.
Life's summer shines, declining autumn glows,
Serene he welcomes winter's soft repose:
Then when he counts accumulated years,
In joyful retrospect each scene appears;
Yet still he presses on with heav'nly views,
Still the bright mark, the radiant prize pursues,
Sees heav'nly fields in bright'ning prospect rise,
And pants impatient for his native skies;
Till freed at last, his spirit soars away
To scenes of boundless bliss, and everlasting day.

The following lines by Dr. Hawkesworth, on this subject, are at once beautiful and pathetic:

Through groves sequestered, dark and still,
Low vales and mossy cells among,
In silent paths the careless rill,
With languid murmurs, steals along.

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[1] Ove nei falsi flutti
Il bel Tamigi amareggiando intoppa.
ARIOSTO.

Awhile it plays with circling sweep,
  And lingering leaves its native plain,
Then pours impetuous down the steep,
  And mingles with the boundless main.

O! let my years thus devious glide,
  Through silent scenes obscurely calm,
Nor wealth, nor strife pollute the tide,
  Nor honour's sanguinary palm.

When labour tires, and pleasure palls,
  Still let the stream untroubled be,
As down the steep of age it falls,
  And mingles with eternity.

No. XVIII.

On the ALTERNATE SUCCESSION *of* DAY *and* NIGHT, *and the* VARIETY *and* VICISSITUDES *of the* SEASONS.

Frigora mitescunt Zephyris; Ver proterit Æstas,
  Interitura, simul
Pomifer Autumnus fruges effuderit; et mox
  Bruma recurrit iners. HORACE.

Rough Winter melts with vernal gales;
  These yield to Summer's scorching ray:
Then Autumn pours his fruits, and fails,
  Dethroned by Winter's circling sway.
WAKEFIELD.

IN all the works of the omnipotent Creator, we perceive that sublimity and simplicity are the striking characteristics. From a few principles he produces the most astonishing effects, and charms us no less by the infinite diversity of his operations, than by the skill and contrivance that are manifested in them. The sun and moon, the planets and the stars, are all governed by the same invariable laws. The single principle of gravitation pervades the whole universe, and puts every spring and wheel of it in motion. From the indiscernible atom to the vast and immeasurable luminaries of heaven, every thing is subject to its dominating influence; and from this active, invisible, and invigorating agent, proceed all that order, harmony, beauty, and variety, which are so conspicuous in the works of creation.

Of all the effects resulting from this admirable scene of things, none can be more pleasing to the Contemplative Philosopher, than the alternate succession of day and night, and the regular return of the season.

> Sweet is the breath of morn,
> And sweet the coming on of grateful evening, mild.
>
> MILTON.

When the sun first appears in the horizon, all Nature is animated by his presence: the magnificent theatre of the universe opens gradually to our view; and every object around us excites ideas of wonder, pleasure, and adoration. After 'riding in all his brightness' through the vault of heaven, this glorious orb is again hidden from our sight, and we are presented with a new scene of equal grandeur and sublimity. The heavens are covered with innumerable stars: the moon, 'rising in clouded majesty, unveils her peerless light;' while the silent solemnity of the scene inspires the mind with unutterable ideas.

> With what an awful world-revolving power
> Were first th' unwieldy planets launched along
> Th' illimitable void! Thus to remain
> Amid the flux of many thousand years,
> That oft has swept the toiling race of men
> And all their laboured monuments away,

Firm, unremitting, matchless, in their course;
To the kind tempered change of night and day,
And of the seasons ever stealing round,
Minutely faithful. THOMSON.

Variety is the source of every pleasure; and the bountiful Author of Nature, in the magnificent display of his wisdom and power, has afforded us every possible means of entertainment and instruction. What a pleasing succession of scenes results from the gradual vicissitudes of the seasons! Spring, summer, autumn, and winter, lead us insensibly through the varied circle of the year, and are no less pleasing to the mind, than necessary toward bringing into maturity the various productions of the earth. Whether the sun flames in the solstice, or pours his mild effulgence from the equator, we equally rejoice in his presence, and bless that omniscient Being, who gave him his appointed course.

At one wide view God's eye surveys
His works in every distant clime;
He shifts the seasons, months, and days,
The short-lived offspring of revolving time;
By turns they die, by turns are born.
Now cheerful Spring the circle leads,
And strews with flowers the smiling meads;
Gay Summer next, whom russet robes adorn,
And waving fields of yellow corn;
Then Autumn, who with lavish stores the lap of Nature spreads;
Decrepit Winter, laggard in the dance,
(Like feeble age opprest with pain)
A heavy season does maintain,
With driving snows, and winds, and rain;
Till Spring, recruited to advance,
The various years rolls round again. HUGHES.

The succession of night and day, and the variety and vicissitudes of the seasons, are phenomena which depend upon the most simple and evident principles. The succession of day and night is occasioned merely by the rotation of the earth upon its axis. The earth turns regularly round this imaginary line once in every twenty-four hours; and as only one half of the globe can be illuminated at the same time, it is evident, that any particular place upon the earth will sometimes be turned toward the sun, and sometimes from it; and being constantly subject to these various positions, will enjoy a regular return of light and darkness. As long as the place continues in the enlightened hemisphere, it will be day; and when, by the diurnal rotation of the earth, it is carried into the dark hemisphere, it will be night.

The motion of the earth upon its axis is from west to east; and this occasions an apparent contrary motion of the celestial bodies from east to west. The sun, for instance, seems to make his daily progress through the heavens from the east toward the west; but this is an optical fallacy, arising from the opposite motion of the earth: for, a spectator being placed in any part of the dark hemisphere, will, by the rotation of the earth upon its axis, be brought gradually into the enlightened one; and, as the sun first appears to him in the east, that luminary will, it is evident, seem to ascend higher and higher toward the west, in proportion as the spectator moves in a contrary direction toward the east; so that, whether the earth turn round upon its axis once in twenty-four hours, or whether the sun, with all the other celestial bodies, moves round in that time, the appearances will be exactly the same: but the latter notion has been long exploded as unphilosophical and absurd.

Every planet, on which observations have been made, is found to have a revolution upon its axis; and, as this revolution is the cause of a constant succession of day and night to every part of their surfaces, so an inclination of the axis of any planet to the plane of its orbit, occasions the vicissitudes of the seasons. Jupiter, whose axis is nearly perpendicular to the plane of his orbit, has equal days and nights, continually, on every part of his surface; their length being each four hours and twenty-eight minutes. But Venus, the Earth, and Mars, having their axes inclined to the plane of their orbits, in angles considerably less than that of 90 degrees, are subject to an annual change of their seasons, and a great variety in the length of their days and nights. But a more scientific discussion on this subject would carry me into too wide a field, and could not be rendered intelligible to my readers without the assistance of some plates, and a variety of references to them. I shall refer, therefore, for a more copious illustration of the subject, to the ingenious author to whom I am indebted for some of these observations [1].

Each season of the year has its incipient, confirmed, and receding state; and each, like the prismatic colours, is undistinguishably blended, in its origin and termination, with that which precedes and that which follows it.

> A simple train,
> Yet so delightful mixed, with such kind art,
> Such beauty and beneficence combined;
> Shade unperceived so softening into shade;
> And all so forming an harmonious whole,
> That, as they still succeed, they ravish still.
>
> THOMSON.

Our favourite poet of the Seasons has not been inattentive to these circumstances in the conduct of his delightful poem. His *Spring* begins with a view of the season, while yet unconfirmed, and partaking of the roughness of Winter; and it is not till after several steps in progression, that it breaks forth in all its ornaments, as the favourite of love and pleasure. His *Autumn*, after a rich prospect of its bounties and splendours, gently fades into 'the sere, the yellow leaf,' and, with the lengthened night, the clouded sun, and the rising storm, sinks into the arms of Winter. To produce something of a similar effect in his *Summer*, a season which, on account of its uniformity of character, admits not of any strongly-marked gradations, he has comprised the whole of his description within the limits of a single day, pursuing the course of the sun from its rising to its setting. A summer's day is, in reality, a just model of the entire season. Its beginning is moist and temperate; its middle, sultry and parching; its close, soft and refreshing. By thus exhibiting all the vicissitudes of Summer under one point of view, they are rendered much more striking than they could have been in a series of feebly contrasted and scarcely distinguishable periods.

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[1] Bonnycastle's Introduction to Astronomy. See also the annual volumes of *Time's Telescope*.

Spring is characterized as the season of the renovation of nature; in which animals and vegetables, excited by the kindly influence of returning warmth, shake off the torpid inaction of Winter, and prepare for the continuance and increase of their several species. The vegetable tribes, as more independent and self-provided, lead the way in this progress. The reviviscent plants emerge, as soon as the genial showers have softened the ground, in numbers 'beyond the power of the botanist to reckon up their tribes.' The opening blossoms and flowers soon call forth, from their winter retreats, those industrious insects, which derive sustenance from their nectareous juices. As the beams of the sun become more potent, the larger vegetables, shrubs, and trees, unfold their leaves;

soon as a friendly concealment is thus pro-
ed for the various nations of the feathered race,
y joyfully begin the course of laborious but
ising occupations, which are to engage them
ing the whole season. The delightful series of
ures, so truly expressive of that genial spirit
t pervades the Spring, which Thomson has
ned on the variety of circumstances attending
passion of the groves, cannot escape the notice
admiration of the most inattentive eye. Af-
ed by the same soft influence, and equally in-
ted to the renewed vegetable tribes for food
shelter, he represents the several kinds of
drupeds as concurring in the celebration of
charming season with conjugal and parental
s. Even man himself, though, from his social
dition, less under the dominion of physical
essities, he properly describes as partaking of
general ardour.

soft and pleasing languor, interrupted only
the gradual progression of the vegetable and
nal tribes toward their state of maturity, forms
leading character of Summer. The active fer-
ntation of the juices, which the first access of
ial warmth had excited, now subsides; and
increasing heats rather inspire faintness and
ction than lively exertions. The insect race
ne seem animated with peculiar vigour, under
more direct influence of the sun.

n Autumn, the promise of the Spring is ful-
d. The silent and gradual progress of matu-
on is completed; and human industry beholds
triumph the rich productions of its toil. The
etable tribes disclose their infinitely various
of *fruit*; which term, while, with respect to
mon use, it is confined to a few peculiar
es of fructification, in the more comprehensive
uage of the naturalist, includes every product

of vegetation by which the rudiments of a future progeny are devoloped, and separated from the parent plant. These are in part collected and stored up by those animals for whose sustenance, during the ensuing sleep of Nature, they are provided. The rest, furnished with various contrivances for dissemination, are scattered by the friendly winds which now begin to blow over the surface of the earth which they are to clothe and decorate. The groves now lose their leafy honours; but, before they are entirely tarnished, an adventitious beauty, arising from that gradual decay which loosens the withering leaf, gilds the Autumnal landscape with a temporary splendour, superior to the verdure of Spring, or the luxuriance of Summer. The infinitely various and ever-changing hues of the leaves at this season, melting into every soft gradation of tint and shades, have long engaged the imitation of the painter, and the contemplation of the poet and the philosopher[1].

These unvarying symptons of approaching Winter now warn several of the winged tribes to prepare for the aerial voyage to those happy climates of perpetual Summer, where no deficiency of food or shelter can ever distress them; and, about the same time, other fowls of hardier constitution, which are contented with escaping the iron winters of the arctic regions, arrive to supply the vacancy. Thus, the striking scenes afforded by that wonderful part of the economy of Nature, the migration of birds[2], present themselves at this season. The thickening fogs, the heavy rains, the swoln rivers, while they deform this sinking period of the year, add new subjects to the pleasing variety which reigns throughout its whole course.

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[1] See No. LXI. on the Decay and Fall of the Leaf.

[2] See No. LXV. and LXVII. on the Migration of *Birds*.

From the fall of the leaf, and withering of the herb, an unvarying death-like torpor oppresses almost the whole vegetable creation, and a considerable part of the animal, during this entire portion of the year. The whole race of insects, which filled every part of the summer landscape with life and motion, are now either buried in profound sleep, or actually no longer exist, except in the unformed rudiments of a future progeny. Many of the birds and quadrupeds are retired to concealments, from which not even the calls of hunger can force them; and the rest, intent only on the preservation of a joyless life, have ceased to exert those powers of pleasing, which, at other seasons, so much contribute to their mutual happiness, as well as to the amusement of their human sovereign. Their social connections, however, are improved by their wants. In order the better to procure their scanty subsistence, and resist the inclemencies of the sky, they are taught by instinct to assemble in flocks; and this provision has the secondary effect of gratifying the spectator with something of novelty and action, even in the dreariness of a wintry prospect.

But it is in the extraordinary changes and agitations which the elements undergo during this season, that the Contemplative Philosopher must principally look for relief from the gloomy uniformity which reigns through other parts of the creation. Scenes are presented to the view, which, were they less frequent, must strike with wonder and admiration the most incurious spectator. The effects of cold are more sudden, and, in many instances, more extraordinary and unexpected, than those of heat. He who has beheld the vegetable productions of even a northern summer, will not be greatly amazed at the richer and more luxuriant, but still resembling growths of the tropics. But one, who has always been accustomed to view water in a liquid and colourless state, cannot form the least conception of the same element as hardened into an extensive plain of solid crystal, or covering the ground with a robe of the purest white. The highest possible degree of astonishment must, therefore, attend the first view of these phenomena; and as, in our temperate climate, but a small portion of the year affords such spectacles, we find that, even here, they have novelty enough to excite agreeable emotions. But it is not to novelty alone that they owe their charms. Their intrinsic beauty is, perhaps, individually superior to that of the gayest objects presented by the other seasons. Where, indeed, is the elegance and brilliancy that can compare with that which decorates every tree and bush on the clear morning succeeding a night of hoar-frost? Or what is the lustre that would not appear dull and tarnished, in competition with a field of snow just glazed over with a frosty incrustation?

In this picturesque review of the seasons, we may find many noble sources of religious as well as philosophical sentiment. The Contemplative Philosopher, while he surveys the grand and beautiful objects that every where surround him, will be prompted to lift his eye to the Great Cause of all these wonders, the Planner and Architect of this mighty fabric, every minute part of which so much awakens his curiosity and admiration. The laws by which this Being acts, the ends which he seems to have pursued, must excite his humble researches; and, in proportion as he discovers Infinite Power in the means, directed by Infinite Goodness in the intention, his soul must be wrapt in astonishment and expanded with gratitude.

The economy of Nature will, to such an observer, be the perfect scheme of an All-wise and Beneficent Mind; and every part of the wide creation will appear to proclaim the praise of its great Author.

I must not conclude this paper without observing, moreover, that the annual space in which the earth performs its revolution round the sun, is so strongly marked by Nature for a perfect period, that all mankind have agreed in forming their computations of time upon it. In all the temperate climates of the globe, the four seasons are so many progressive stages in this circuit, which, like the acts in a well constructed drama, gradually disclose, ripen, and bring to an end, the various business transacted on the great theatre of Nature. The striking analogy which this period, with its several divisions, bears to the course of human existence, has been remarked and pursued by writers in every age and country. Spring has been represented as the youth of the year, the season of pleasing hope, lively energy, and rapid increase[1]. Summer has been resembled to perfect manhood, the season of steady warmth, confirmed strength, and unremitting vigour. Autumn, while it bestows the rich products of full maturity, is yet ever hastening to decline, and has, therefore, been aptly compared to that period, when the man, mellowed by age, yields the valuable fruits of wisdom and experience, but daily exhibits increasing symptons of decay. The cold, cheerless, and sluggish Winter has, almost without a metaphor, been termed the decrepit and hoary old age of the year[2]. And Thomson, whose noble poem is not merely a descriptive and philo-

[1] See No. XXI. Vernal Reflections.

[2] See, in particular, Lucretius, v. 737; and Ovid, xv. 196.

sophical, but an eminently moral and religious one, has, from this view of his subject, deduced the most instructive lesson:

Behold, fond Man!
See here thy pictured life; pass some few years,
Thy flowering Spring, thy Summer's ardent strength,
Thy sober Autumn fading into age,
And pale concluding Winter comes at last,
And shuts the scene. Ah! whither now are fled
Those dreams of greatness, those unsolid hopes
Of happiness, those longings after fame,
Those restless cares, those busy bustling days,
Those gay-spent festive nights, those veering thoughts,
Lost between good and ill, that shared thy life?
All now are vanished! Virtue sole survives,
Immortal never-failing friend of man,
His guide to happiness on high.

The melancholy poet of the Night too, adducing the revolutions of Nature as evidences of the immortality of man, exhibits the following beautiful and instructive picture of the seasons:

Look Nature through, 'tis revolution all;
All change, no death. Day follows night, and night
The dying day. Stars rise, and set, and rise.
Earth takes th' example: see, the Summer gay
With her green chaplet and ambrosial flowers,
Droops into pallid Autumn. Winter gray,
Horrid with frost, and turbulent with storm,
Blows Autumn and his golden fruits away,
Then melts into the Spring. Soft Spring, with breath
Favonian, from warm chambers of the south,
Recals the first. All, to reflourish, fades;
As in a wheel, all sinks, to reascend:
Emblem of man, who passes, not expires.

No. XIX.

ON SLEEP.

Somnus avaris,
Inserpit curis, pronusque per aëra nutat,
Grata laboratæ referens oblivia vitæ. STATIUS.

Sleep steals away
The wild desires of men, and toils of day,
And brings, descending through the silent air,
A sweet forgetfulness of human care. POPE.

MANKIND, without having recourse to ex-raordinary events, must acknowledge the wisdom nd omnipotence of God, in a variety of instances hich, to an inattentive observer, seem of small mportance. The most common occurrences, the aily revolutions in nature and in our own bodies, re alone sufficient to enforce the strongest convic-ion that the world was created by an infinitely ise, powerful, and benevolent Being, who never eases to govern and superintend the whole. Of e infinite variety of wonders of which He is the uthor, one alone shall be the subject of my pre-ent discussion; and, although it occurs every day, t does not the less merit to be observed, and to be he object of admiration.

If every day did not produce fresh instances of the gratitude of mankind, we might, perhaps, be at a ss to know, why so liberal and impartial a bene-ctor as Sleep, should meet with so few historians r panegyrists. Writers, in general, are so totally bsorbed by the business of the day, as never to turn eir attention to that power, whose officious hand) seasonably suspends the burden of life; and with-ut whose interposition man would not be able to endure the fatigue of the most beneficial labour, or the struggles of the most successful opposition.

The poets, however, among all those that enjoy the blessings of sleep, seem to be exempted from this censure. How much Statius considered the evils of life as assuaged and softened by the balm of slumber, we may discover by the pathetic invocation which he poured forth in his waking nights. Virgil and Milton call Sleep the gift of Heaven. Ovid has deified Sleep, and having given a beautiful description of his house, makes Iris, the messenger of Juno, thus address him:

> Somne, quies rerum, placidissime Somne Deorum, &c.
>
> LIB. XI.

> O sacred Rest,
> Sweet pleasing Sleep, of all the powers the best!
> O peace of mind, repairer of decay,
> Whose balms renew the limbs to labours of the day,
> Care shuns thy soft approach, and sullen flies away!
>
> DRYDEN.

Statius has likewise given a description of the House of Sleep; but Ariosto has not merely improved, but surpassed them both. Ovid, in particular, says there is no porter at the door; *Custos in limine nullus.* But Ariosto has greatly enriched the picture, by placing Oblivion and Silence as centinels before it.

> Sotto la nera selva una capace
> E spaziosa grotta entra nel sasso:
> Di cui la fronte l'edera seguace
> Tutta aggirando va con storto passo.
> In questo albergo il grave Sonno giace;
> L' Ozio da un canto corpulento, e grasso;
> Da l'altro la Pigrizia in terra siede;
> Che non può andare, e mal reggersi in piede.
>
> Lo smemorato Oblio stà sù la porta;
> Non lascia entrar, non riconosce alcuno,
> Non ascolta in basciata, nè riporta,
> E parimente tien cacciato ogn' uno.

Il Silenzio va intorno, e fa la scorta;
Ha le scarpe di feltro, e'l mantel bruno;
Ed à quanti n'incontra di lontano,
Che non debban venir, cenna con mano.

My readers will be pleased, perhaps, with some more poetical eulogies of Sleep:

O sweet refreshing Sleep! thou balmy cure
Of sickness and of pain!
How has thy gentle power at length relieved me!
O soft oblivion of surrounding ills,
How grateful to th' afflicted are thy charms!
EURIP. BY HUGHES.

Sleep, that knits up the ravelled sleeve of Care,
The death of each day's life, sore Labour's bath,
Balm of hurt minds, great Nature's second course,
Chief nourisher in life's feast! SHAKSPEARE.

Thou silent power, whose welcome sway
Charms every anxious thought away;
In whose divine oblivion drowned,
Sore Pain and weary Toil grow mild,
Love is with kinder looks beguiled,
And Grief forgets her fondly cherished wound;
O whither hast thou flown, indulgent god?
God of kind shadows and of healing dews,
Whom dost thou touch with thy Lethæan rod?
Around whose temples now thy opiate airs diffuse?
AKENSIDE.

Haste, haste, sweet stranger! From the peasant's cot,
The ship-boy's hammock, or the soldier's straw,
Whence Sorrow never chased thee; with thee bring
Not hideous visions, as of late; but draughts
Delicious of well-tasted, cordial rest;
Man's rich restorative; his balmy bath,
That supples, lubricates, and keeps in play
The various movements of this nice machine,
Which asks such frequent periods of repair. YOUNG.

Casa, in one of his sonnets, with the usual Ita-
blage of epithets, has this apostrophe:

lla quieta, umida, ombrosa
do figlio!

K 2

> O Sleep, sweet son of the peaceful, humid, umbrage
> night!

In a word, to conclude, these instances of hom in the poets to 'the downy god,' Cowley, am the other felicities of his darling solitude, has forgotten to number the privilege of sleeping w out disturbance; and, among the gifts of Nat he assigns a rank to the poppy, 'which is scatte (says he) over the fields of corn, that all the ne of man may be easily satisfied, and that *bread* *sleep* may be found together[1].'

How wonderful is it that a thinking being, w in every diurnal revolution, experiences the sw and invigorating refreshment of sleep, should ne once reflect on his situation in those moments temporary insensibility; or, at least, that he sho never consider it as one of the most remarkable fects of the Divine Goodness! We have no id of any thing extraordinary, when sleep spreads soft and benevolent influence over us. We are c tent to imagine, that this machine, our body, ormed for that situation; and that the inclination hich impels us to sleep proceeds merely from naural causes. But sleep, perhaps, may be considered two points of view. On the one hand, there is othing in it which does not necessarily result from ur nature: on the other, there is something so triking and wonderful in this natural effect, that it well worthy of the most minute examination.

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[1] He wildly errs who thinks I yield
Precedence in the well-clothed field
  Tho' mixed with wheat I grow;
Indulgent Ceres knew my worth,
And, to adorn the teeming earth,
  She bade the POPPY blow.

Nor vainly gay the sight to please,
But blest with power mankind to ease,
  The Goddess saw me rise:
'Thrive with the life-supporting grain,'
She cried, 'the solace of the swain,
  The cordial of his eyes.

'Seize happy mortal, seize the good;
My hand supplies, thy *sleep* and *food*,
  And makes thee truly blest:
With plenteous meals enjoy the day,
In slumbers pass the night away,
  And leave to fate the rest.'

Adventurer, No, 3

It is certainly a proof of the wisdom of our Creaor, that we fall asleep imperceptibly. Were we nce to attempt to watch the moment when sleep akes possession of us, that very attempt would prove n obstacle to its approach, and we could not sleep while that idea was retained. Sleep comes unsumnoned: it is the only change in our manner of exstence in which reflection bears no part; and the more we endeavour to produce it, the less successful hall we prove. The Divine Being, therefore, has rdained sleep with such a design, and in such a manner, that it proves an agreeable necessity to all mankind; and he has rendered it alike independent of the understanding and of the will. Our situation, indeed, during the time of sleep, is wonderful. We live; but we live without knowing, without perceiving it. The palpitations of the heart, the circulation of the blood, with digestion, and, in a word, all the animal functions, continue to be performed without interruption. The mind appears, as it were, to suspend its activity, for a time: by degrees, it loses all sensation, every distinct idea. The senses are deadened, and stop their wonted operations. The muscles, by degrees, are moved more slowly, till all voluntary motion ceases. This change begins in the forehead: then the muscles of the eyelids, and of the neck, arms, and feet, are so much deprived of their activity, that the man seems to be metamorphosed into a plant. The situation of the brain becomes such, that it cannot transmit to the soul the same ideas as when we are awake. The soul perceives no object, although the nerve of vision is not altered; and it would see nothing, were the eyes to be even open. The ears not shut, and yet they hear nothing. In a word, those who have leisure to consider the subject more minutely still, by entering into anatomical inquiries concerning it, will find an unceasing source of admiration, in the wonderful preparations, and the tender care, which the Divine Being has employed, to procure us the blessings of sleep.

There is something in the approaches of sleep so importunate and irresistible, that it cannot long remain unsatisfied; and if, as some have done, we consider it as the tax of life, we cannot but consider it also as a tax that must be paid, unless we would cease to be men. On this account, Alexander the great declared that nothing convinced him that he was not a divinity, but his not being able to live without sleep.

Sleep is necessary to all men, in order to repair, and to invigorate again, both the intellectual and corporeal faculties, when exhausted by long exertion and fatigue. It is necessary to the happy, to prevent satiety, and to endear life by a short absence; and to the miserable, to relieve them by intervals of oblivion and repose. Such, indeed, is our frame, that, whether happy or miserable, life is, to the greatest part of mankind, such as could not be endured without frequent intermissions of existence.

> Sunk to rest,
> The traveller forgets his toil; his charge,
> The centinel; her death-devoted babe
> The mother's painless breast.

Sleep has the same effect upon men, which night has upon colours: it reduces all to an equality. But, although it is the chief of all earthly blessings, it is not equally kind to all. It is justly appropriated to industry and temperance. Refreshing rest, and peaceful nights, are chiefly the portion of him who lies down weary with honest labour, and free from the fumes of indigested luxury. It is the just doom of indolence and gluttony, to be inactive without ease, and drowsy without repose. '*The sleep of the labouring man* (says the Preacher) *is sweet, whether he eat little or much; but the abundance of the rich will not suffer him to sleep.*'

Those, who are not grateful for the unspeakable blessing of sleep, must be such only that never knew the want of it. But how easy is it for disease, or grief, or infirmities, or old age, to deprive us of all the blessings of repose. Then shall we be compelled to acknowledge, that sleep is at once the most urgent necessity of Nature, and the most inestimable blessing of Heaven. Shakspeare, therefore, has finely contrasted the sweets of a sound sleep and the horrors of a restless night, in this soliloquy of king Henry the fourth:

How many thousands of my poorest subjects
Are at this hour asleep! O gentle Sleep,
Nature's soft nurse, how have I frighted thee,
That thou no more wilt weigh my eyelids down,
And steep my senses in forgetfulness?
Why rather, Sleep, ly'st thou in smoky cribs,
Upon uneasy pallets stretching thee,
And hushed with buzzing night-flies to thy slumbers,
Than in the perfumed chambers of the great,
Under the canopies of costly state,
And lulled with sounds of sweetest melody?
O thou dull god, why ly'st thou with the vile
In loathsome beds, and leav'st the kingly couch
A watch-case, or a common larum-bell?
Wilt thou, upon the high and giddy mast,
Seal up the ship-boy's eyes, and rock his brains
In cradle of the rude imperious surge;
And in the visitation of the winds,
Who take the ruffian billows by the top,
Curling their monstrous heads, and hanging them

With deaf'ning clamours in the slippery shrouds;
That, with the hurley, death itself awakes?
Canst thou, O partial Sleep, give thy repose
To the wet seaboy in an hour so rude,
And in the calmest and the stillest night,
With all appliances and means to boot,
Deny it to a king? then happy low! lie down;
Uneasy lies the head that wears a crown.

Nothing resembles death so much as sleep; and this resemblance is so striking and apparent, that sleep has been called his brother, his half-brother, his image and his counterfeit,

O'er their brows death-counterfeiting sleep
With leaden legs and batty wings doth creep.
SHAKSPEARE.

The same thought somewhat more expanded occurs in the following beautiful Latin epigram:

Somne levis, quamquam certissima mortis imago,
Consortem cupio te, tamen, esse tori:
Alma quies, optata veni; nam, sic, sine vitâ
Vivere, quam suave est; sic, sine morte, mori.

Come, gentle sleep, attend thy votary's prayer,
And, though, death's image, to my couch repair!
How sweet, thus lifeless, yet with life to lie,
Thus, without dying, O how sweet to die!
DR. WOLCOTT.

'Sleep (says sir Thomas Browne) is so like death, that I dare not trust it without my prayers, without bidding a half adieu unto the world, and taking a farewell in a colloquy with God.'

Gratitude for a blessing so inestimable as sleep ought certainly to prevent any rational being from abusing it, by the extremes either of indulgence or of abstinence. Not to enjoy the gifts of Heaven would bespeak insensibility and ingratitude? but then he is to be censured, who, through indolence and sloth, prolongs the hours destined to repose; and equally to be condemned is he, who from the incentives of

rice and ambition, or the love of pleasure, de-
'es himself of a proper portion of that refreshment
ch is so necessary to all. To say what that proper
tion is, would be to invade, perhaps, the province
ıe physician? but Nature, in this respect, as well
every other, requires but little: and seven or
ıt hours of peaceful and uninterrupted sleep,
n to be sufficient; allowance being made for
difference of age and constitution.

o inestimable is the blessing of sleep, that not
the poets, as I have observed before, but the sa-
l scriptures, also, represent it as the gift of Hea-
. '*God giveth his beloved sleep*,' says the
lmist; and Solomon observes, that to them who
ep sound wisdom and discretion' it is promised,
; '*their sleep shall be sweet*.' Considerations
ıis kind should induce us to cultivate those habits
iety and virtue, which are the only sources of
e in life, and serenity in the hour of death;
h can alone enable us to approach the divine Be-
with humble hope and godly confidence, in the
fortable language of the Psalmist: '*I will both
me down in peace and sleep; for thou, Lord,
makest me dwell in safety*.' With sentiments
these, replete with piety, if not with poetry, I
l conclude this paper:

Thou, whose nature cannot sleep,
On my temples centry keep.
Sleep is a death; oh ! make me try
By sleeping what it is to die;
And as gently lay my head
In my grave as on my bed,
Howe'er I rest, great God, let me
Awake again, at least with thee;
And thus assured, behold I lie
Securely or to wake or die.
These are my drowsy days; in vain
I do now wake to sleep again;
O come that hour, when I shall never
Sleep again, but wake for ever.

SIR T. BROWNE.

No. XX.

ON DREAMS.

Et cui quisque ferè studio devinctus adhæret,
Aut quibus in rebus multùm sumus morati,
Atque in quâ ratione fuit contenta magis mens,
In somnis eadem plerumque videmur obire.
LUCRETIUS.

And when soft sleep the body lays at ease,
And from the heavy mass the fancy frees,
Whate'er it is in which we take delight,
And think of most by day, we dream by night.
ANON.

FROM the consideration of Sleep, which was the subject of my last paper, the transition is very natural to that of Dreams, the wonderful and mysterious phenomena of that state, the ideal transactions and vain illusions of the mind. According to Wolfius, an eminent Silesian philosopher, every dream takes its rise from some sensation, and is continued by the succession of phantasms in the mind. He observes, that when we dream, we imagine something, or the mind produces phantasms; but no phantasm can arise in the mind without some previous sensation. And yet, it is not easy to confirm this by experience; it being often difficult to distinguish those slight sensations, which give rise t dreams, from phantasms, or objects of imagination[1] —The series of phantasms, which thus constitute dream, seem to be accounted for by the law of th imagination, or association of ideas; although i may be very difficult to assign the cause of ever minute difference, not only in different subjects, bu in the same, at different times, and in different circumstances. And hence Formey, who adopts the opinion of Wolfius, concludes, that those dreams are supernatural, which either do not begin by sensation, or are not continued by the law of the imagination[1].

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[1] Wolf. Psychol. Empir. sect. 123.

This opinion is as old as Aristotle, who asserted, that a dream is only, the φαντασμα, or *appearance* of things, excited in the mind, and remaining after the objects are removed[2]. The opinion of Lucretius, in my motto, was likewise that of Tully[3]. Mr. Locke, also, traces the origin of dreams to previous sensations, and says, that the dreams of sleeping men, are all made up of the waking man's ideas, though, for the most part, oddly put together[4]. And Dr. Hartley, who explains all the phenomena of the imagination by his theory of vibrations and associations, says, that dreams are nothing but the imaginations or reveries of sleeping men, and that they are deducible from three causes, namely, the impressions and ideas lately received, and particularly those of the preceding day; the state of the body, particularly of the stomach and brain; and association[5].

Were I to enter more deeply into the subject of this mysterious phenomenon, my present lucubration would become too abstruse; and, after all, perhaps, no philosophical or satisfactory account can be given of it. Such of my readers, therefore, who would wish for a more minute inquiry into the opinions I have stated above, I must refer to the respective authors whom I have quoted[1].

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[1] Mem. de l'Acad. de Berlin, tom. ii, p. 316.

[2] De Insomn. cap. 3.

[3] Quæ in vitâ usurpant homines, cogitant, curant, vident, quæque agunt vigilantes, agitantque, ea cuique in somno accidunt. *De Div.*

[4] Essay on Human Understanding, book ii, chap. 1, sec. 17.

[5] Observations on Man, vol. i, sec. 5, p. 383.

From the scenes of nocturnal imagination, the reader, who is fond to find amusement even in a serious subject, will be glad, perhaps, to be transported into the regions of poetical fiction. And here we find, that the Fancy is not more sportive in dreams, than are the poets in their descriptions of her nocturnal vagaries.—I shall begin first with that admirable speech in Romeo and Juliet, on the effects of the imagination in dreams:

> O, then I see, Queen Mab hath been with you.
> She is the Fancy's midwife, and she comes
> In shape no bigger than an agat stone
> On the fore finger of an alderman;
> Drawn with a team of little atomies,
> Athwart men's noses as they lie asleep:
> Her waggon-spokes made of long spinners legs;
> The cover, of the wings of grasshoppers;
> The traces, of the smallest spider's web;
> The collars, of the moonshine's watery beams;
> Her whip, of cricket's bone; the lash, of film;
> Her waggoner, a small grey-coated gnat,
> Not half so big as a round little worm,
> Prickt from the lazy finger of a maid.
> Her chariot is an empty hazel nut,
> Made by the joiner squirrel, or old grub,
> Time out of mind the fairies coachmakers:
> And in this state she gallops night by night,
> Thro' lovers brains, and then they dream of love;
> On courtiers knees, that dream on curtsies strait;
> O'er lawyers fingers, who strait dream on fees;
> O'er ladies lips, who strait on kisses dream,
> Which oft the angry Mab with blisters plagues,
> Because their breaths with sweetmeats tainted are.
> Sometimes she gallops o'er a lawyer's nose,
> And then dreams he of smelling out a suit:
> And sometimes come she with a tithe-pig's tail,
> Tickling the parson as he lies asleep;

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[1] See also Baxter on the Soul, vol. ii. Stewart's Elements of the Philos. of the Mind, p. 328, 348, and Good's Lucretius, note to Lib. iv. ver. 936.

Then dreams he of another benefice:
Sometimes she driveth o'er a soldier's neck,
And then he dreams of cutting foreign throats,
Of breaches, ambuscades, Spanish blades,
Of healths five fathom deep! and then anon
Drums in his ears, at which he starts and wakes;
And being thus frighted, swears a prayer or two,
And sleeps again.

Lucretius, in the verses that immediately follow my motto, and Petronius, in his poem on the Vanity of Dreams, had preceded our immortal bard in a description of the effects of dreams on different kinds of persons. Both the passages, to which I allude, only serve to show the vast superiority of Shakspeare's boundless genius: their sense is thus admirably expressed by Stepney:

At dead of night, imperial Reason sleeps,
And Fancy, with her train, her revels keeps.
Then airy phantoms a mixed scene display,
Of what we heard, or saw, or wished by day;
For Memory those images retains
Which passion formed, and still the strongest reigns;
Huntsmen renew the chase they lately run,
And generals fight again their battles won.
Spectres and furies haunt the murderer's dreams;
Grants and disgraces are the courtier's themes,
The miser spies a thief, or a new hoard;
The cit's a knight; the sycophant a lord,
Thus Fancy's in the wild distraction lost,
With what we most abhor, or covet most.
Honours and state before this phantom fall;
For Sleep, like Death, its image, equals all.

Chaucer, in his tale of the Cock and Fox, has a fine description, thus versified by Dryden:

Dreams are but interludes which Fancy makes:
When monarch Reason sleeps, this mimic wakes;
Compounds a medley of disjointed things,
A court of coblers, and a mob of kings:
Light fumes are merry, grosser fumes are sad:
Both are the reasonable soul run mad;

And many monstrous forms in sleep we see,
That neither were, nor are, nor e'er can be.
Sometimes forgotten things, long cast behind,
Rush forward in the brain, and come to mind.
The nurse's legends are for truths received,
And the man dreams but what the boy believed.
Sometimes we but rehearse a former play,
The night restores our actions done by day,
As hounds in sleep will open for their prey.
In short, the farce of dreams is of a piece,
Chimeras all; and more absurd or less.

And Shakspeare again:

I talk of dreams,
Which are the children of an idle brain,
Begot of nothing but vain phantasy,
Which is as thin of substance as the air,
And more inconstant than the wind.

Nor must Milton be omitted:

In the soul
Are many lesser faculties, that serve
Reason as chief; among these Fancy next
Her office holds; of all external things,
Which the five watchful senses represent,
She forms imaginations, aëry shapes,
Which Reason joining, or disjoining, frames
All what we affirm, or what deny, or call
Our knowledge or opinion; then retires
Into her private cell, when Nature rests.
Oft in her absence mimic Fancy wakes,
To imitate her; but misjoining shapes,
Wild works produces oft, but most in dreams,
Ill matching words or deeds, long past or late.

From these poetical descriptions let us proceed to take a view of the principal phenomena in dreaming. But I shall first give Mr. Locke's beautiful account of *Modes of Thinking*, as it will greatly illustrate the preceding observations:

" When the mind (says he) turns its view inward upon itself, and contemplates its own actions *thinking* is the first that occurs. In it the mind observes a great variety of modifications, and thence receives distinct *ideas*. Thus the perception, which actually accompanies, and is annexed to any impression on the body, made by an external object, being distinct from all other modifications of thinking, furnishes the mind with a distinct idea, which we call *sensation;* which is, as it were, the actual entrance of an idea into the understanding by the senses. The same idea, when it occurs again without the operation of the like object on the external sensory, is *remembrance:* if it be sought after by the mind, and with pain and endeavour found, and brought again in view, it is *recollection:* if it be held there long under consideration, it is *contemplation:* when ideas float in our minds without any reflection or regard of the understanding, it is that, which the French call *reverie*[1]; our language has scarce a name for it. When the ideas that offer themselves (for as I have observed in another place, while we are awake, there will always be a train of ideas succeeding one another in our minds) are taken notice of, and, as it were, registered in the memory, it is *attention:* when the mind, with great earnestness, and of choice, fixes its view on any idea, considers it on all sides, and will not be called off by the ordinary solicitation of other ideas, it is what we call *intention*, or *study*. *Sleep* without dreaming is rest from all these: and *dreaming* itself, is the having of ideas (while the outward senses are stopped, so that they receive not outward objects with their usual quickness) in the mind, not suggested by any external objects, or known occasion, nor under any choice or conduct of the understanding at all; and whether that which we call *ecstacy*, be not dreaming with the eyes open, I leave to be examined."

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[1] There is a phenomenon in the mind, which, though it happens to us while we are perfectly awake, yet approaches the nearest to sleep of any I know. It is called the *reverie*, or, as some term it, the *brown study*, a sort of middle state between waking and sleeping; in which, though our eyes are open, our senses seem to be entirely shut up, and we are quite insensible of every thing about us, yet we are all the while engaged in a musing indolence of thought, or a supine and lolling kind of roving from one fairy scene to another, without any self-command; from which, if any noise or other accident rouse us, we wake as from a real dream, and are often as much at a loss to tell how our thoughts were employed, as if we had waked from the soundest sleep. This is frequently called *dreaming*, sometimes *absence*, a thing often observed in lovers and people of a melancholy, or indeed speculative turn. *Fordyce's Dial. on Education*, vol. ii, p. 255.

Dr. Beattie, in his Dissertations Moral and Critical, has an ingenious essay on this subject, in which he attempts to ascertain, not so much the *efficient*, as the *final* causes of this phenomenon, and to obviate those superstitions in regard to it, which have sometimes troubled weak minds. He labours, with great earnestness, to show, that dreams may be of use in the way of physical admonition; that persons, who attend to them with this view, may make important discoveries with regard to their health; that they may be serviceable as the means of moral improvement; that, by attending to them, we may discern our predominant passions, and receive good hints for the regulation of them; that they may have been intended by Providence to serve as an amusement to the mental powers; and that dreaming is not universal, because, probably, all constitutions do not require such an intellectual amusement.—In observations of this kind we may discover the ingenuity of fancy and the sagacity of conjecture; we may find amusement in the arguments, but we look in vain for satisfaction. Nature, certainly, does nothing in vain; but I am far from thinking, that man is able, in every case, to discover her intentions. Final causes, perhaps, ought never to be the subject of human speculation, but when they are plain and obvious. To substitute vain conjectures, instead of the designs of Providence, on subjects where those designs are beyond our reach, serves only to furnish matter for the cavils of the sceptical, and the sneers of the licentious.

Among the many striking phenomena in our dreams, it may be observed, that, while they last, the memory seems to lie wholly torpid, and the understanding to be employed only about such objects as are then presented, without comparing the present with the past. When we dream, we often converse with a friend who is either absent or dead, without remembering that the ocean or the grave is between us. We float like a feather upon the wind; for we find ourselves this moment in England, and the next in India, without reflecting that the laws of nature are suspended, or inquiring how the scene could have been so suddenly shifted before us. We are familiar with prodigies; we accommodate ourselves to every event however romantic; and we not only reason, but act upon principles, which are in the highest degree absurd and extravagant. Our dreams, moreover, are so far from being the effect of a voluntary effort, that we neither know of what we shall dream, nor whether we shall dream at all.

But sleep is not the only time in which strange and unconnected objects involve our ideas in confusion. Beside the *reveries* of the day, of which I have already spoken, we have, in a moral view, our *waking dreams*, which are not less chimerical, and impossible to be realized, than the imaginations of the night.

Night visions may befriend——
Our *waking* dreams are fatal. How I dreamt
Of things *impossible*! (Could sleep do more?)

Of joys perpetual in perpetual change!
Of stable pleasures on the tossing wave!
Eternal sunshine in the storms of life!
How richly were my noontide trances hung
With gorgeous tapestries of pictured joys!
Joy behind joy, in endless perspective!
Till, at death's toll,——
Starting I woke, and found myself undone.

Sometimes, in our *sleeping* dreams, we imagine ourselves involved in inextricable woe, and enjoy, at waking, the ecstacy of a deliverance from it. "And such a deliverance (says Dr. Beattie) will every good man meet with at last, when he is taken away from the evils of life, and awakes in the regions of everlasting light and peace; looking back upon the world and its troubles, with a surprise and a satisfaction, similar in kind (though far higher in degree) to that which we now feel, when we escape from a terrifying dream, and open our eyes to the sweet serenity of a summer morning." Sometimes, in our dreams, we imagine scenes of pure and unutterable joy; and how much do we regret, at waking, that the heavenly vision is no more! But what must be the raptures of the good man, when he enters the regions of immortality, and beholds the radiant fields of permanent delight! The idea of such a happy death, such a sweet transition from the dreams of earth to the realities of heaven, is thus beautifully described by Dryden, in his poem entitled Eleonora.

She passed serenely with a single breath;
This moment perfect health, the next was death;
One sigh did her eternal bliss assure;
So little penance needs, when souls are almost pure.
As gentle dreams our waking thoughts pursue;
Or, one dream past, we slide into a new;
So close they follow, and such wild order keep,
We think ourselves awake, and are asleep;
So softly death succeeded life in her:
She did but dream of heaven, and she was there!

No. XXI.

VERNAL REFLECTIONS.

e doux Printemps revient, et ranime à la fois
es oiseaux, les zephyrs, et les fleurs, et ma voix.
ans les champs, dans les bois, sur les monts d'alentour,
ue tout rit de bonheur, d'esperance, et d'amour!
DE LILLE.

Lo! where the rosy-bosomed Hours,
  Fair Venus' train appear,
Disclose the long-expecting flowers,
  And wake the purple year!
The attic warbler pours her throat,
Responsive to the cuckoo's note,
  The untaught harmony of spring;
While, whisp'ring pleasure as they fly,
Cool zephyrs through the clear blue sky
  Their gathered fragrance fling. GRAY.

'HE multiplicity of beautiful objects in the
ation, and the variety and constant vicissitude
he seasons, are less to be wondered at by the
itemplative Philosopher, than the inattention
indifference with which they are too often be-
l. A rural excursion is productive of very
erent reflections in ordinary minds from what
dom would suggest with admiration, and de-
ion utter with reverence and awe. Man, as if
owed with no higher faculties than the beasts
the field, 'wanders often with brute uncon-
ius gaze,' and discerns not 'the mighty Hand,
t, ever busy,' upholds, informs, and actuates
whole.

What Tully has observed on a different occa-
ı, may be applicable likewise to all contempla-
ıs on the beauties of Nature and the Seasons,
is a very forcible recommendation of them:

Omnia profectò, cum se à cœlestibus rebus referet ad humanas, excelsiùs magnificentiùsque et dicet et sentiet: 'The contemplation of celestial things will make a man both speak and think more sublimely and magnificently, when he descends to human affairs.'—They have a tendency to exalt the mind above the low and grovelling ideas that enslave the vulgar, the prepossessions of ignorance, and the terrors of superstition. By a kind of philosophical necessity, they superinduce a habit of serious and devotional reflection, and, by a happy consequence, a delight in the exercises of piety, benevolence, and virtue. They are productive, also, of the sweetest and most permanent satisfaction; so well is philosophy, in this respect, entitled to the noble eulogy of Milton:

> How charming is divine philosophy!
> Not harsh and crabbed, as dull fools suppose,
> But musical as is Apollo's lute,
> And a perpetual feast of nectared sweets,
> Where no crude surfeit reigns.

With the poets in every age Spring has been one of the most favourite subjects. When they would describe the beauties of Paradise, and the felicities of the Golden Age, their Spring flourishes in perpetual verdure, and smiles with everlasting pleasure. Thus Milton adorns his Eden:

> Airs, vernal airs,
> Breathing the smell of field and grove, attune
> The trembling leaves, while universal Pan,
> Knit with the Graces and the Hours in dance,
> Led on th' eternal Spring.

And Ovid describes his Golden Age,

> Ver erat æternum, placidique tepentibus auris
> Mulcebant zephyri natos sine semine flores.

> The flow'rs unsown, in fields and meadows reigned,
> And western winds immortal Spring maintained.
> DRYDEN.

One of the most beautiful ornaments of poetry is the creation of imaginary beings, or the personification of inanimate objects. Such a favourite as the Spring could not, in course, be neglected or forgotten. It has been described as a youth of a most beautiful air and shape, but not yet arrived at that exact symmetry of parts, which maturer years might be supposed to give him. There is such a bloom, however, in his countenance, with such sweetness, complacency, and pleasure, that he appears created to inspire every bosom with delight. He is dressed in a flowing mantle of green silk, interwoven with flowers; a chaplet of roses on his head, and a jonquil in his hand. Primroses and violets spring up spontaneously at his feet, and all nature revives at his exhilarating aspect. Flora attends him on one hand, and Vertumnus, in a robe of changeable silk, on the other. Venus, with no other ornament than her own beauties, follows after. She is succeeded by the Graces with their arms entwined, and with loosened girdles, moving to the sound of soft music, and striking the ground alternately with their feet. The Months that properly belong to this season, appear likewise in his train, with suitable emblematic decorations.

Pleasure is represented as taking her flight in Winter to cities and towns, and revisiting the gladdened country in Spring. Mrs. Barbauld has beautifully described this, as well as the gradual progress of the season, from its earliest infant efforts, to the perfection of vernal beauty in the delightful month of May.

When Winter's hand the rough'ning year deforms,
And hollow winds foretel approaching storms,
Then Pleasure, like a bird of passage, flies
To brighter climes, and more indulgent skies;

Cities and courts allure her sprightly train,
From the bleak mountain and the naked plain;
And gold and gems with artificial blaze,
Supply the sickly sun's declining rays.
But soon, returning on the western gale,
She seeks the bosom of the grassy vale:
There, wrapt in careless ease, attunes the lyre,
To the wild warblings of the woodland quire:
The daisied turf her humble throne supplies,
And early primroses around her rise.

* * * * *

Now the glad earth her frozen zone unbinds,
And o'er her bosom breathe the western winds.
Already now the snowdrop dares appear,
The first pale blossom of th' unripened year;
As Flora's breath, by some transforming pow'r,
Had changed an icicle into a flow'r:
Its name and hue the scentless plant retains,
And Winter lingers in its icy veins.
To these succeed the violet's dusky hue,
And each inferior flow'r of fainter hue;
Till riper months the perfect year disclose,
And Flora cries exulting, See my rose.

What a wonderful revolution, indeed, in the universal aspect of Nature does the return of this lovely season exhibit! After having been long bound up with frost, or overspread with snow, the earth once more displays all the variety of plants and flowers, is arrayed with the most beautiful and enlivening verdure, variegated with a numberless variety of hues, and exhales odours so exquisitely pure and fragrant, that every sense of every creature is awake to inexpressible delight.

Forth in the pleasing Spring
His beauty walks, His tenderness and love.
Wide flush the fields; the softening air is balm;
Echo the mountains round; the forest smiles;
And every sense, and every heart is joy. THOMSON.

The *blossoms of trees* in Spring present to the eye the most agreeable spectacle; and while they yield the most exquisite delight to the fervent admirer of the beauties of nature, afford to the moralist a never failing source of the most pleasing reflections :

> Fair pledges of a fruitful tree,
> Why do you fall so fast?
> Your date is not so past,
> But you may stay yet here awhile,
> To blush and gently smile;
> And go at last.
>
> What were you born to be
> An hour or two's delight;
> And so to bid good night!
> 'Twas pity Nature brought you forth
> Merely to show your worth,
> And lose you quite.
>
> But you are lovely leaves, where we
> May read how soon things have
> Their end, though ne'er so brave:
> And after they have shown their pride,
> Like you awhile they glide
> Into the grave. HERRICK.

None of the other seasons can vie with Spring in loveliness and amenity. It has the same order among them that the morning has among the divisions of the day, and youth among the stages of life. It may be called the favourite season of harmony; for the warblings of the feathered tribes have been observed to have now a peculiar wildness and sweetness of melody. Nor is its sweet influence confined to the songsters of the groves: it pervades the whole animal creation. But I must confine my observations to its influence on man, that I may not be led to exceed the limits of this Paper. Thomson, in his inimitable Seasons, has left nothing on this subject for future poets to describe.

In the opening of Spring, and the subsequent renovation of Nature, how very sensibly is the human soul exhilarated by that sense of pleasure, which inspires the birds with melody, and the whole creation with joy. In this season, when we contemplate the smiling scenes around, those secret overflowings of gladness are diffused over the soul, which compose what Milton expressively calls ' vernal delight,' and which I have heard denominated, with no less beauty and propriety, ' the smile of Nature.' What an exquisite sense of this does the virtuous philosopher experience! The creation, particularly in this lovely season, is a perpetual feast to the mind of a good man. From all that he beholds, he receives instruction and delight.

In every flower, leaf, or blade of grass, a series of fables may be read, whose moral is in the heart. To those who have known the pure and tranquil enjoyment of a mind at leisure, to repose and dream amid the green earth's woods and vales, and find that there is in the material world around us more than will fill the gaze of the artist, or inspire the reverie of the enthusiast—that there is, in all that the divine Intelligence has moulded, a principle of moral meaning and an inherence of moral life; to such, the following lines from Mr. Wilson's Hymn to Spring will recal many feelings of luxury. Speaking of the flowers, buds, lambs, &c. that come with Spring, he says,

O blessed things!
At sight of this your perfect innocence
The sterner thoughts of manhood melt away
Into a mood as mild as woman's dreams.
The strife of working intellect, the stir
Of hopes ambitious, the disturbing sound
Of fame, and all that worshipped pageantry
That ardent spirits burn for in their pride,
Fly like disparting clouds, and leave the soul
Pure and serene as the blue depths of heaven.

The poet thus continues his pleasing theme:

> Now is the time in some meek solitude
> To hold communion with those innocent thoughts
> That blest our earlier days;—to list the voice
> Of Conscience murmuring from her inmost shrine,
> And learn if still she sing the quiet tune
> That filled the ear of youth. If then we feel,
> That mid the powers, the passions, and desires,
> Of riper age, we have still kept our hearts
> Free from pollution, and, mid tempting scenes,
> Walked on with pure and unreproved steps,
> Fearless of guilt as if we knew it not!
> Ah, me! with what a new sublimity
> Will the green hills lift up their sunny heads,
> Ourselves as stately! smiling will we gaze
> On the clouds whose happy home is in the heavens;
> Nor envy the clear streamlet that pursues
> His course, 'mid flowers and music, to the sea.
> But dread the beauty of a vernal day,
> Thou trembler before memory!

Providence, indeed, has adorned the whole creation with such a variety of beautiful and useful objects, that it is impossible for a mind, not imbruted by mere sensual enjoyments, to contemplate the scenes around without some of the sweetest internal sensations of which man can be susceptible. But when to the delightful satisfaction which rural objects afford, we add an occasional attention to the studies of natural philosophy, our relish for the beauties of the creation s quickened, and rendered not only pleasing to he imagination, but to the understanding; and it s an unquestionable truth, that the man who exends his inquiries into the works of Nature, muliplies, in some degree, the inlets to happiness. The philosopher is not content with the lulling murmur of brooks, or the enlivening melody of irds, with the shade of embowering woods, the erdure of fields, or the embroidery of meadows. He will reflect, on the contrary, on the infinite variety of benevolent purposes to which they are all subservient, and the wonders of that Divine Wisdom of which they all exhibit such impressions. While the pleasures of the eye, in course, are heightened, his soul is exalted to that rational admiration, which insensibly leads to love and adoration; and while he 'walks superior amid the glad creation, musing praise, and looking lively gratitude,' with a kind of sacred ecstacy he exclaims,

> These are thy glorious works, Parent of Good,
> Almighty, Thine this universal frame.
> Thus wondrous fair: Thyself how wondrous then
> Unspeakable! MILTON.

While unusual sweetness thus inspires the whole creation with a purer joy, the moral philosopher is led to inquire into the natural effects of this delightful influence, not only on the frame, but on the heart of man. The affections, he is fond to imagine, are all attuned to benevolence, and each discordant passion soothed to serenity and peace. This beautiful idea is adopted by Thomson;

> Can fierce passions vex his breast,
> While every gale is peace, and every grove
> Is melody?

With what a generous satisfaction too will Humanity reflect on the restorative effects of Spring! The convalescent, so lately wretched, so long oppressed by the heavy load of pain, and languor, and disease, now feel, as it were, a new creation; and sweet are the cheering sensations, sweet the unwonted joys, that now recal them to the exertions of strength and happiness of health.

> Fair the face of Spring,
> When rural songs and odours wake the morn
> To every eye; but how much more to his
> Round whom the bed of sickness long diffused

Its melancholy gloom! How doubly fair,
When first with fresh-born vigour he inhales
The balmy breeze, and feels the blessed sun
Warm at his bosom, from the springs of life
Chasing oppressive damps and languid pain!
AKENSIDE.

But as the human mind is not universally the same, the renovation of spring sheds not on all alike its enlivening influence. Some persons, at times, experience sensations very different from that gaiety which is supposed to be inseparable from the vernal season. Amid the bright verdure of the earth, the gay variety of trees and flowers, and the serenity of the blue concave, a kind of tranquil melancholy enters into all their solitary moments, which the beauties of the landscape, and the melody of the birds, will rather soothe than overcome. Among the various reasons that may be given for the occurrence of such pensive ideas, is the recollection, perhaps, that the Spring brings back with it the remembrance, but not the return of our youthful scenes of hilarity and strength; and that while Nature, in regular vicissitude, is renewed in youth and beauty, man hastes apace to that wintry state of infirmity and decrepitude, when the brightest Spring must cease to charm, and life itself expire, under the pressure of accumulated years. Indulging such sentiments as these, one may be disposed to address Spring in the words of Mirtillo, in the Pastor Fido of Guarini, the turn of which has been so beautifully copied by Milton[1].

[1] Thus with the year
Seasons return, but not to me returns
Day, or the sweet approach of ev'n or morn,
Or sight of vernal bloom, or summer's rose,
Or flocks, or herds, or human face divine,

O Primavera, gioventù dell' anno,
Bella madre di fiori,
D'erbe novelle, e di novelli amori;
Tu torni ben, ma teco
Non tornano i sereni
E fortunati dì delle mie gioie.

Thus admirably imitated by Drummond of Hawthornden:

Sweet Spring! thou com'st with all thy goodly train,
Thy head in flames, thy mantle bright with flowers,
The zephyrs curl the green locks of the plain,
The clouds for joy in pearls weep down the showers.
Sweet Spring! thou com'st—but ah! my pleasant hours,
And happy days, with thee come not again;
The sad memorials only of my pain,
Do with thee come, which turn my sweet to sours,
Thou art the same, which still thou wert before,
Delicious, lusty, amiable, fair;
But she, whose breath imbalmed thy wholesome air,
Is gone; nor gold, nor gems can her restore:
Neglected virtue, seasons go and come,
When thine forgot lie closed in a tomb!

Let then considerations of this kind inculcate some useful lesson, and they may, at times, be innocently, if not too frequently indulged. Let them teach the young and gay the necessity of making use, at the same time, of the spring of the year and the spring of life; of acquiring, while their minds may yet be impressed with new images, the love of innocent enjoyments, and a passion for useful and virtuous wisdom. In fine, let them remember, as a fine writer has expressed it, 'that a blighted spring makes a barren year, and that the vernal flowers, however beautiful and gay, are only introduced by Nature as preparatives for autumnal fruits.'

To persons advanced in life, true wisdom will not fail to administer the noblest motives for manly consolation and rejoicing hope. A good man will reflect, that since it is impossible for his declining years to return to their first spring of health and vigour, it is yet in his power to soften the inconveniences he may feel, by the cultivation of such virtues, and the enjoyment of such pleasures, as have a natural tendency to produce an easy and contented mind. Taught to look into himself, he will wisely reflect on the vanity of setting his heart on external enjoyments. He will feel nothing of that unsocial disposition, which the gloom of austerity excites. On the contrary, a pensive tenderness, a serene but not unpleasing melancholy will be diffused over his soul, inspiring the sweet tranquillity of benevolence, yet awake, at the same time, to all the active energy of goodness. Hence the charms of a virtuous life, and of a devout intercourse with the God of Seasons, 'the Great Arbiter of life and death.' For he knows, '*that his Redeemer liveth, and that he shall stand at the latter day upon the earth; and though after his skin worms destroy his body, yet in his flesh shall he see God.*' Hence he looks forward, not merely with a serenity of soul, but with the aspirations of piety, and the triumph of anticipating faith: he looks forward to that blissful period, when the vicissitude of seasons shall be no more; when '*the spirits of the just made perfect*' shall enjoy the society of angels and archangels, resplendent in celestial beauty and happy in perpetual spring.

No. XXII.

A MOONLIGHT SCENE.

Lucidum cœli decus—
Siderum regina— HORACE.

'*The beauty of heaven, the glory of the stars.*'
SON OF SIRACH.

THERE are certain great and magnificent objects in the creation, the contemplation of which has a tendency to produce a kind of internal elevation and expansion; to raise the mind above its ordinary state; and to excite a degree of wonder and astonishment, which it cannot often express. The emotion is certainly delightful; but it is entirely of the serious kind; and it is attended most commonly, by a degree of solemnity and awe, very different from the sprightly sensations inspired by scenes, that glow, as it were, with excessive radiance and overpowering beauty.

The scenes, indeed, which are most calculated to inspire 'sublimities of thought,' are not so much the smiling landscape, the variegated fields, and dazzling skies, as the venerable woods, the high-impending cliff, or the headlong torrent. Hence, too, nocturnal views are commonly the most sublime. The firmament, filled with stars, that are scattered through infinite space, with such magnificent profusion, impresses the imagination with ideas far more grand and awful, than when we view it enlightened by all the splendour of the sun. Of this sentiment is our favourite poet of the Night:

And see, Day's amiable sister sends
Her invitation, in the softest rays

Of mitigated lustre; courts thy sight,
Which suffers from her tyrant brother's blaze.
Night grants thee the full freedom of the skies,
Nor rudely reprimands thy lifted eye—
Night opes the noblest scenes, and sheds an awe,
Which gives those venerable scenes full weight,
And deep reception in th' intendered heart.

'he objects, moreover, which the eye contem-
lates by day, do not affect the pensive mind with
pleasure so serene, if I may so express myself,
s the milder glories of a moonlight evening.
Ve then behold a new picture of things, which
more delicately shaded, and disposed into softer
ghts, than that which the radiant ruler of the day
ad before displayed. Each tumultuous care and
nportant agitation has vanished with 'the garish
ye of day.' The discordant passions are soothed
ito serenity and peace, by the stillness of all
round. In this happy moment we imbibe, as it
rere, the universal repose of Nature; for there
not an object but seems to be at rest; and the
nusing wanderer can scarce forbear to exclaim
rith Lorenzo,

How sweet the moonlight sleeps upon this bank[1]!
Here will we sit, and let the sounds of music
Creep in our ears; soft stillness and the night
Become the touches of sweet harmony.
Sit, Jessica; look how the floor of heaven
Is thick inlaid with patterns of bright gold:
There's not the smallest orb, which thou behold'st,
But in his motion, like an angel, sings,
Still quiring to the young-eyed cherubim.
Such harmony is in immortal souls.

The greatest poets in every age have vied with
ach other in the description of a moonlight even-
ng. But, among all the treasures of ancient and

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[1] Merchant of Venice, Act v.

modern poetry, I know not one superior, for pleasing imagery, and variety of numbers, than that of Milton:

> Now came still Evening on, and Twilight gray
> Had in her sober livery all things clad;
> Silence accompanied; for beast and bird,
> They to their grassy couch, these to their nests,
> Were slunk, all but the wakeful nightingale;
> She all night long her amorous descant sung;
> Silence was pleased: now glowed the firmament
> With living sapphirs: Hesperus, that led
> The starry host, rode brightest, till the Moon,
> Rising in clouded majesty, at length,
> Apparent queen, unveiled her peerless light
> And o'er the dark her silver mantle threw.

I can recollect only one description that is worthy to be mentioned after this. It is of a fine moonlight night, by way of simile, in the eighth book of the Iliad. It is esteemed, indeed, a masterpiece of nocturnal painting. But Milton's description, it must be observed, leaves off where that of Homer begins:

> As when the Moon, refulgent lamp of night
> O'er heav'n's clear azure sheds her sacred light,
> When not a breath disturbs the deep serene,
> And not a cloud o'ercasts the solemn scene,
> Around her throne the vivid planets roll,
> And stars unnumbered gild the glowing pole;
> O'er the dark trees a yellower verdure shed,
> And tip with silver every mountain's head;
> Then shine the vales, the rocks in prospect rise,
> A flood of glory bursts from all the skies:
> The conscious swains, rejoicing in the sight,
> Eye the blue vault, and bless the useful light. POPE.

Nor have the Sacred Writers been unobservant of this bright 'sovereign of the shades[1].' The patriarch Job observes, that he could behold '*the*

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[1] Nemorumque potens Diana. HORACE.

moon walking in brightness,' without being seduced to the adoration of aught but the great Creator of the universe. And the Psalmist, from a view of the nocturnal heavens, expresses himself in the most reverential language of astonishment and humility: '*When I consider the heavens, the work of thy fingers; the moon and the stars, which thou hast ordained; what is man that thou art mindful of him, and the son of man that thou visitest him?*'—Nor must we omit to mention again the wise Son of Sirach, although his writings are not admitted into the sacred canon: '*The Lord made the moon also to serve in her season, for a declaration of times, and a sign of the world. From the moon is the sign of feasts, a light decreaseth in her perfection. The month is called after her name, increasing wonderfully in her changing, being the instrument of the armies above, shining in the firmament of heaven; the beauty of heaven, the glory of the stars, an ornament giving light to the highest places of the Lord. At the command of the Holy One they will stand in their order, and never faint in their watches.*'—This is paraphrased with great elegance and spirit by Mr. Broome, the honoured and not unequal coadjutor of Pope, in his poetical version of the Odyssey:

By Thy command the Moon, as daylight fades,
Lifts her broad circle in the deep'ning shades;
Arrayed in glory, and enthroned in light,
She breaks the solemn terrors of the night;
Sweetly inconstant in her varying flame,
She changes still, another, yet the same!
Now in decrease, by slow degrees she shrouds
Her fading lustre in a veil of clouds;
Now of increase, her gathering beams display
A blaze of light, and give a paler day;
Ten thousand stars adorn her glittering train,
Fall when she falls, and rise with her again;
And o'er the deserts of the sky unfold
Their burning spangles of sidereal gold:

Through the wide heavens she moves serenely bright,
Queen of the gay attendants of the night;
Orb above orb in sweet confusion lies,
And with a bright disorder paints the skies.

But this noble subject is not monopolized by the poets: it affords ample room for inquiry to the Contemplative Philosopher. Of all the celestial orbs, the Moon, next to the Sun, has the most beneficial influence upon our globe. And if her beautiful appearance in the skies, with such regular and constant variations, were insufficient to attract our attention, she would at least inspire us with the warmest sentiments of gratitude and adoration toward the beneficent Being, who has formed and stationed her in such a manner, as to be productive of the most signal advantages to the Earth.

By the naked eye we can discover many of the most remarkable phenomena that distinguish the Moon from the innumerable orbs around her. We find her to be only a secondary planet, or attendant upon the Earth, revolving round it, from change to change, in twenty-nine days, twelve hours, and forty-four minutes, and accompanying its circuit round the Sun in the space of our year. Her diameter is 2180 miles, and her distance from the centre of the earth 240,000. She goes round her orbit in twenty-seven days, seven hours, and forty-three minutes, moving at the rate of 2290 miles every hour; and she turns round her axis exactly in the same time that she revolves round the Earth, which is the reason of her keeping always the same side toward us, and that her day and night, taken together, is as long as our lunar month.

The Moon, like the Earth, is an orbicular and opaque body, which shines only by reflecting the Sun's light. While that half of her, therefore, which is toward the Sun, is illuminated, the other half is dark and invisible. Hence, she disappears when she comes between the Earth and the Sun: because her dark side is then toward us. When she is gone somewhat forward, we see a little of her enlightened side, which still increases to our view, as she advances forward, until she comes to be opposite the Sun, where her entire enlightened side is toward the Earth, and she appears with a full illuminated orb, which we call the Full Moon; her dark side being then turned away from the Earth. From the full she decreases gradually as she proceeds through the other half of her course; showing us less and less of her bright side every day, till her next change or conjunction with the Sun, and then she disappears as before. These different appearances having been observed by Endymion, an ancient Grecian, who watched her motions, it gave rise to the fable of Diana falling in love with him.

These different appearances of the Moon, which we call her Phases, are sufficient to demonstrate, that she shines not only by any light of her own; for otherwise, as her form is spherical, we should always behold her, like the Sun, with a full orb.

Philosophers, moreover, have observed, that one half of the Moon has no darkness at all; the Earth constantly affording it a strong light, in the absence of the Sun; while the other half has alternately a fortnight's darkness and a fortnight's light. Our Earth serves as a moon to the Moon, waxing and waning regularly, but appearing thirteen times as large, and affording her thirteen times as much light as she does to us. When she changes to us, the Earth appears full to her; when she is in her first quarter to us, the Earth is in its third quarter to her; and *vice versâ*.

The Moon has no visible atmosphere, of any density, surrounding her, as we have; for if she had we could never see her edge so well defined as it appears; but there would be a sort of mist or haziness about her, which would make the stars look fainter when they are seen through it[1]. But it has been proved by observation, that the stars which disappear behind the Moon, retain their full lustre, until they seem to touch her very edge, when they vanish in an instant. Nor can there be any seas in the Moon; for if there were, she could have no clouds, nor rains nor storms as we have; because she has no such atmosphere to support the vapours which occasion them. And it is apparent to all, that when the Moon is above our horizon in the night-time, she is visible, unless the clouds of our atmosphere hide her from our view; and every part of her appears constantly with the same serene and unclouded aspect. Those dark parts of the Moon, which were formerly thought to be seas, are now found to be only vast and deep cavities, and places which reflect not the light of the Sun so strongly as others. For, by observations through the telescope, the Moon has been found to be full of high mountains and deep vallies; and some of these mountains, by comparing their height with the diameter of the Moon, are found to be three times higher than the highest hills upon our Earth.

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[1] The reasoning above given in the text is not quite correct. Melanderhialem has found theoretically, and Schroeter by his observations, that the refracting power of the Moon's atmosphere is only about a twenty-ninth part of that of the Earth's. And as the height of the inferior strata of the air which are dense enough to break the rays of light in a manner perceptible to us, does not exceed 648 yards, an altitude equivalent to less than two-fifths of a second of space; the weakening of the light cannot occur more than a quarter of a second of time before the star is hid behind the moon: and such a short interval must, of necessity, escape the notice of common observers. Schroeter, however, has noticed it, and farther records many observations upon lunar mountains, volcanoes, seas, &c.; for which see his 'Selenotopographical Fragments,' or the article MOON in vol. viii. of the PANTOLOGIA.

Such are the principal phenomena that distinguish this beautiful luminary. And if we advert to the signal benefits of which it is productive to our globe, we can never be sufficiently grateful to the omnipotent Creator, who in this, as well as in all his works, has displayed infinite wisdom and inexhaustible goodness. How cheerless and uncomfortable would be our nights, but for the constant returns of light, which this our sister orb, our faithful and inseparable companion, dispenses in such agreeable vicissitude! How highly useful are even her eclipses, in our atmospherical, geographical, and chronological calculations! How salutary too is her attractive influence, which sways the ocean, and actuates the world of waters; which swells the tides, and perpetuates the regular returns of ebb and flow; and which thus not only preserves the liquid element itself from putrefaction, but the surrounding continents, in course, from infection and disease[1].

I will not here urge those sentiments of devotion, those grand and august conceptions, which this subject has a tendency to inspire. Yet not wholly to conclude this paper without a moral, I will just intimate to my fair readers, that Mr. Pope, from the mild and serene appearance of the Moon, contrasted with the dazzling brightness of the Sun, exhibits a beautiful comparison, and a portrait, not less beautiful, of an estimable woman. This, I am persuaded, will inculcate a lesson, which, if properly attended to by the fair, cannot fail to heighten and perpetuate every charm:

Ah! friend, to dazzle let the vain design;
To raise the thought, and touch the heart be thine;

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[1] On the probability of the Moon being inhabited, see No. XLIII, *on the Sun.*

That charm shall grow, while what fatigues the ring:
Flaunts and goes down, an unregarded thing:
So when the sun's broad beam has tired the sight,
All mild ascends the moon's more sober light;
Serene in virgin modesty she shines,
And unobserved the glaring orb declines.
Oh! blest with temper, whose unclouded ray
Can make to-morrow cheerful as to-day:
She, who can love a sister's charms, or bear
Sighs for a daughter with unwounded ear;
She, who ne'er answers till a husband cools,
Or if she rules him, never shows she rules;
Charms by accepting, by submitting sways,
Yet has her humour most, when she obeys;
Let fops of fortune fly which way they will,
Disdain all loss of tickets or codille;
Spleen, vapours, or smallpox, above them all,
And mistress of herself, though china fall.

No. XXIII.

REFLECTIONS ON DEW.

' *Who hath begotten the drops of dew?*' JOB.

Non liquidi gregibus fontes, non gramina deerunt:
Et quantum longis carpent armenta diebus,
Exigua tantum gelidus ros nocte reponet. VIRGIL.

There, for thy flocks, fresh fountains never fail;
Undying verdure clothes the grassy vale;
And what is cropt by day the night renews,
Shedding refreshful stores of cooling dews.
J. WARTON.

With starry splendour on the hawthorn bough
And graceful wild-rose, shines the *copious dew*;
That precious lymph of Nature, which dilates
The ruby lip of ev'ry infant bud,
And lavish on the level turf remains
In silver beauty. ANON.

THERE is not a phenomenon of Nature more common, or more beautiful than that of Dew.

The poets in course have seized it with avidity, to decorate their favourite themes, and particularly their descriptions and personifications of the Morning. But I do not recollect that the venerable sire of poetry, who abounds in these, has once embellished them by any allusions to dew. Indeed, in Pope's Translation of the Iliad and Odyssey, there are three different passages in which Aurora sprinkles the *dewy* lawn with light[1]. But this is the embellishment of the translator, for in neither of these passages, is the epithet *dewy* in the original[1].

Homer, however, has not forgotten the dews, in that variety of beautiful decorations with which he describes the bed of Jupiter:

> Celestial dews, descending o'er the ground,
> Perfume the mount, and breathe ambrosia round.
>
> Pope.

But Milton gives them more importance: he introduces them into his descriptions with a peculiar felicity:

> Now Morn her rosy steps in th' eastern clime
> Advancing, *sowed the earth with orient pearl.*

This fine metaphor of *sowing the earth* has been before used by Lucretius:

> Sol etiam summo de vertice dissipat omnes
> Ardorem in partes, et *lumine conserit arva.*

> The sun, resplendent, at his noontide height,
> Shines forth, and *sows the fields with dazzling light.*

But this wants much of the propriety of Milton's *sowing the earth with orient pearl;* for the dew-drops have unquestionably something of the shape and appearance both of scattered seeds and sparkling gems.

But our divine bard, in speaking of the prodigious host of Satan, has introduced dew into a most be tiful simile:

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[1] Pope's Iliad, viii, 1, xxiv, 1000. and Odyssey xvii. 7.

An host,
Innumerable as the stars of night
Or *stars of Morning, dew-drops, which the sun*
Impearls on every leaf and every flower.

Innumerable as the stars is an old simile; but of the stars of morning, dew-drops, seem as ne it is beautiful. And the sun impearls them; is turns them by his reflected beams to seem pearls, as the morn was said above to sow the ea with orient pearl.

A favourite comparison with our English p is that of tears to dew, or of dew to tears. T Shakspeare:

And that same *dew*, which sometime on the buds
Was wont to swell like round and orient pearls,
Stood now within the pretty flow'ret's eyes,
Like *tears* that did their own disgrace bewail.

In Samson Agonistes, when Dalilah comes to v her eyeless husband, she is afraid to approach; Milton has made her silence most beautifully pressive: the Chorus tells Samson,

Yet on she moves, now stands, and eyes thee fixed,
About t' have spoke, but now, with head declined,
Like a fair flow'r surcharged with dew, she weeps,
And words addressed seem into tears dissolved,
Wetting the borders of her silken veil.

In Virgil, the *Ros in tenera pecori gratissimus he* —*the dew on the tender grass grateful to the cat* is rendered by Dryden *the pearly drops of morn* *dews*, and by Dr. Warton *the Morning's earl* *tears*. Nor has Pope neglected them in his El to the Memory of an unfortunate Lady:

Yet shall thy grave with rising flowers be drest,
And the green turf lie lightly on thy breast:
There *shall the Morn her earliest tears bestow*,
There the first roses of the year shall blow.

And most of my readers will recollect the celebrated couplet of Lord Chesterfield, in his Advice to a Lady in Autumn:

> The dews of the evening most carefully shun;
> Those *tears of the sky* for the loss of the sun.

Gray, in his Elegy in a Country Churchyard, exhibits a fine picture of a melancholy man:

> Haply some hoary-headed sage may say,
> 'Oft have we seen him at the peep of dawn,
> *Brushing with hasty steps the dews away*,
> To meet the sun upon the upland lawn.'

But I must now leave the pleasing entertainment of poetry, to attend to the more instructive discussions of philosophy.—The dew is generally ranked by naturalists among the aqueous meteors, those bodies that exist in the atmosphere in a flux and transitory state. It is a dense, moist vapour, found upon the earth in spring and summer mornings, in the form of a misling rain, and it is chiefly collected while the sun is below the horizon.

It has been disputed whether dew is formed from the vapours *ascending* from the earth during the night-time, or from the *descent* of such as have been already raised through the day. The most remarkable experiments, adduced in favour of the first hypothesis, are those of M. Dufay, of the Royal Academy of Sciences at Paris. He supposed, that if dew ascended, it must wet a body placed low down sooner than one placed in a higher situation; and, if a number of bodies were placed in this manner, the lowermost would be wetted first; and the rest in like manner, gradually up to the top.

To determine this, he placed two ladders against one another, meeting at their tops, spreading wide asunder at the bottom, and so tall as to reach thirty-two feet high. To the several steps of these he fastened large squares of glass like the panes of windows, placing them in such a manner, that they should not overshade one another. On the trial it appeared exactly as M. Dufay had apprehended. The lower surface of the lowest piece of glass was first wetted, then the upper, then the lower surface of the pane next above it; and so on, till all the pieces were wetted to the top. Hence it appeared plain to him, that dew consisted of the vapours ascending from the earth during the night-time; which, being condensed by the coldness of the atmosphere, are prevented from being dissipated as in the daytime by the sun's heat. He afterwards tried a similar experiment with pieces of cloth, instead of panes of glass, and the result was quite conformable to his expectations. He weighed all the pieces of cloth the next morning, in order to know what quantity of water each had imbibed, and found those that had been placed lowermost considerably heavier than such as had been placed at the top; although he confesses that this experiment did not succeed so perfectly as the former.

M. Muschenbroek, who embraced the contrary opinion, thought he had invalidated all M. Dufay's proofs, by repeating his experiments with the same success, on a plane covered with sheet-lead. But to this M. Dufay replied, that there was no occasion to suppose the vapour to rise through the lead, nor from that very spot; but that as it arose from the adjoining open ground, the continual fluctuation of the air could not but spread it abroad, and carry it thither in its ascent.

But although M. Muschenbroek's experiment is not sufficient to overthrow those of M. Dufay, it may still remain dubious whether dew rises or falls. One thing, which seems to favour the hypothesis of its descent is, that in cloudy weather there is little or no dew to be observed. From this, M. De Luc brings an argument in favour of the last hypothesis, the descent of dew; and he accounts for it in the following manner: when there are no clouds in the air, the heat of the inferior air and of that which rises from the earth, is dissipated into the superior regions; and then the vapours, which are dispersed throughout the air, condense, and fall down in dew. But when the clouds continue, they separate the inferior from the superior part of the atmosphere, and thus prevent the dissipation of the heat, by which means the vapours remain suspended. When the sky grows cloudy, some hours after sunset, although the heat has been sensibly diminished; it is again increased; because, continuing to rise out of the earth, it is accumulated in the inferior air.—But neither can this be deemed a positive proof of the descent of dew; since we may as well suppose the heat of the atmosphere to be great enough to dissipate it in its ascent, as to keep it suspended after its ascent through the day.

On the other hand, its being found in greater quantities on bodies placed low down, than on such as are high up, is no proof of the ascent of dew; for the same thing is observed of rain. A body placed low down receives more rain than one placed in an elevated situation; and yet the rain certainly descends from the atmosphere. The reason why the dew appears first on the lower parts of bodies may be, that, in the evening, the lower part of the atmosphere is first cooled, and consequently most disposed to part with its vapour. It is also certain, that part of the water contained in the air may be condensed at any time on the sides of a glass, by means of cold, so as to run down its sides in small drops like dew. It seems, therefore, that this subject is not sufficiently determined by such experiments as have yet been made; nor indeed does it appear easy to make such experiments, as shall be perfectly decisive on the matter.

But however this may be determined, it is certain that several substances, exposed to the same dew, receive and charge themselves with it in a very different manner; some more, others less, and some not at all. The drops seem to make a sort of choice of what bodies they shall fix themselves to: glass and crystals are those to which they adhere in the most ready manner, and in the largest quantity: but metals of all kinds never receive them at all, nor do the drops ever adhere to them. The reason of this is, probably, because metals promote evaporation more than glass does. Thus, if a piece of metal and a piece of glass are both made equally moist, the former will be found to dry in much less time than the latter. Hence it would seem, that there is between metals and water some kind of repulsion: and this may be sufficient to keep off the very small quantity that falls in dew; for whatever tends to make water evaporate, after it is actually in contact with any substance, tends also to keep the water from ever coming into contact with it.

Of the dew of plants, it has been observed, that it is probably only the moisture that continually exhales through the orifices of their vessels, and not a vapour collected by their leaves; this dew being exhaled by each plant, according to the peculiar structure of its vessels, and the situation of their orifices. Indeed, it is certain, that plants, which have been shut up in vessels, and covered by glasses, have collected a greater quantity of dew, than those that stood in the open air; and further, the drops are gathered in those parts where the orifices of the vessels are manifestly open, and not all over the leaves, nor in the upper or lower leaves only (which would be the case if they arose from ambient vapour) but in all the leaves without distinction. The oil, or honey-dew, which is sometimes exhaled in summer by trees and herbs, and which has been found to settle on the oak, ash, &c. is of this kind.

Mr. Thomas Melvill, a very ingenious writer in the Essays, Physical and Literary, by the Edinurgh Society, published some observations on the ilver-like appearance of drops of water on the eaves of colewort. ‘ It is common (says he) to dmire the volubility and lustre of drops of rain hat lie on the leaves of colewort, and some other egetables; but no philosopher, as far as I know, as put himself to the trouble of explaining this urious phenomenon. Upon inspecting them arrowly, I find, that the lustre of the drop arises rom a copious reflection of light from the flattened art of its surface contiguous to the plant: I oberve further, that when the drop rolls along a art which has been wetted, it immediately loses ll its lustre; the green plant being then seen learly through it: whereas, in the other case, it s hardly to be discerned.

‘ From these two observations laid together, we ay observe, that the drop does not really touch he plant when it has the mercurial appearance, ut hangs in the air at some distance from it, by he force of a repulsive power; for there could ot be any copious reflection of white light from ts under surface, unless there were a real interval etween it and the surface of the plant.

‘ If that surface were perfectly smooth, the under urface of the drop would be so likewise; and vould therefore show an image of the illuminating ody by reflection, like a piece of polished silver: ut as it is considerably rough and unequal, the nder surface becomes rough likewise; and so by eflecting the light copiously in different directions, ssumes the resplendent white colour of unpolished ilver.

‘ After it is proved by optical argument, that the drop is not really in contact with the plant that supports it, we may easily conceive whence its wonderful volubility arises, and why it leaves no track of moisture where it rests.'

Mr. Melvill's explanation will enable us to account for that common phenomenon, the suspension of the drops of dew on the very summits of the blades of grass, &c. and their assuming that pearly, or resplendent white colour, which he observed in the drops on the leaves of colewort. This ingenious explanation, at the same time, shows the extensive utility of optical principles, in leading to the knowledge of things which would be otherwise inaccessible.

The limits of this paper will not allow me to enlarge on the great benefit of dews in the refreshment of the earth, and the nourishment of plants. 'How sensibly (says a pious author) has this dew refreshed the vegetable kingdom! The fervent heat of yesterday's sun, had almost parched the face, and exhausted the sweets of nature. But what a sovereign restorative are these cooling distillations of the night! How they gladden and invigorate the languishing herbs! Sprinkled with these reviving drops, their verdure deepens, their bloom is new-flushed; their fragrance, faint or intermitted, becomes potent and copious.'

In hot countries, and in places where it rains but seldom, the dew of the night supplies, in some measure, the want of rain. In the sacred scriptures, therefore, it is represented as a great blessing: '*Blessed of the Lord* (says Moses, speaking of Joseph) *be his land for the precious things of heaven, for the dew,* &c. And the want of it is represented as a curse: '*Ye mountains of Gilboa* (said David) *let there be no dew!*' The favour of the Divine Being is compared to the dew: '*I will be* (says the Lord, by Hosea) *as the dew unto*

Israel: he shall grow as the lily, and cast forth his roots as Lebanon.' Heavenly doctrine, or the word of God, is likewise compared to dew: '*My doctrine* (says Moses) *shall drop as the rain, my speech shall distil as the dew, as the small rain upon the tender herb, and as the showers on the grass:'* that is, my doctrine shall have the same effect upon your hearts, as dew has upon the earth: it shall render them soft, pliable, and fruitful.—But the admirable allusions to dew, in holy writ, are too numerous to be quoted.

In a word, these 'transparent beauties of the morn' not only furnish us with poetic images and philosophic knowledge, but with very powerful motives also for a life of piety, benevolence, and virtue. Their great utility to the vegetable kingdom, in particular, should lead us to the unceasing adoration of that gracious Being, who created nothing, which has existence, merely for an object of idle speculation. When we consider, moreover, how silently and insensibly 'the light-footed dews' fulfil the gracious purposes of our common Benefactor; incessantly dispensing nutriment to vegetable life, and refreshment to animated being; how persuasively should this instruct the rich and opulent, to let their secret bounty, unostentatious as the dew of heaven, descend continually to revive the drooping hearts of modest and unassuming worth. For what are the high and mighty of the earth, without that bliss-diffusing spirit of humanity, whose exertions, while they tend every day to dignify its noble possessor, prepare and mature him for immortality? What, I repeat it, are illustrious titles and unbounded affluence, without this divine spirit, but the momentary radiance of the same morning dews, which glitter awhile, and then vanish for ever?

Since the Contemplative Philosopher was originally written, a variety of theories of *dew* have been advanced by different persons. One of the most ingenious is that stated by Dr. Wells in his 'Essay on Dew,' published in 1814. Mr. Wilson and Mr. Six thought the formation of dew was accompanied by the evolution of cold; and this opinion was once held by Dr. Wells. But subsequent observations led him to question its accuracy; and he was not long after enabled to ascertain, by direct experiments, that the temperature of bodies *sinks* before any dew is deposited on them; and that the subsequent deposition of dew is the consequence of this coldness. This philosopher infers, therefore, that the deposition of dew has precisely the same cause as the appearance of moisture on the outside of a glass, or metallic vessel, when a liquor considerably colder than the air has been shortly before poured into it.

All bodies have the property of radiating heat. During the day, the heat lost by radiation is more than supplied by the solar heat; so that the temperature of bodies is increased during the day, instead of being diminished. But during the night the heat radiated by the bodies on the surface of the earth penetrates into the sky and does not again return to them. Hence their temperature must be constantly diminishing from radiation, and they will become and continue colder than the air during the whole night; thus being in the state for the deposition of dew upon their surfaces. This, however, will only happen when the sky is clear, and the atmosphere calm. If the sky be covered with clouds, they will radiate back nearly as much heat as they receive; and thus prevent the terrestrial bodies from cooling considerably. And in windy nights, the agitation of the atmosphere compensates for its *bad* conducting power, and thus prevents that pid lowering of temperature requisite to the roduction of dew.

Upon these and analogous principles Dr. Wells ccounts for the various phenomena of dew, as ell as several other appearances which he attriutes to similar causes: for these, however, the quisitive reader must turn to the Essay itself.

No. XXIV.

ON THE FOOD OF PLANTS.

> Each tree, each plant, from all its branching roots,
> Amid the glebe small hollow fibres shoots;
> Which drink with thirsty mouths the vital juice,
> And to the limbs and leaves their food diffuse;
> Peculiar pores peculiar juice receive,
> To this deny, to that admittance give.
>
> BLACKMORE.

IN treating, in a former paper[1], on the inluence of the air on vegetation, I was led to take otice of the *pabulum*, or food of plants, as a ubject of future discussion. This is a subject, ndeed, which has been productive of considerable ispute. What is generally understood by the erm itself, is such matter, of whatever kind, as eing added and united to the first stamina of lants, at their sowing, or to their roots, and ence to their trunks and other parts afterward, ives them their increase, or, in other words, is elf the matter of that increase. The great art f the husbandman is the giving this food to plants, in the best manner, and to the greatest advantage. But, before he can expect to arrive at any true knowledge in this article, it is necessary that he should know what this food or matter of nourishment is. There are five things generally allowed to contribute to the growth and increase of plants; namely, nitre, water, air, fire, and earth. But it has been much disputed which of all these it is that increases, or is properly the food of the plant. Much has been said of the acid spirit residing in the air; but as this is sharp enough to corrode iron bars, it is too sharp to be fit for nourishing tender plants. Nitre is said to nourish them; but its true office is not actually nourishing, but preparing other things to nourish them. Nitre applied to the root of a plant will kill it; but, at a distance, it so attenuates, cuts, and divides the viscous matter found in the earth, that after this they are fit to nourish plants, although they were not so before. Water has been thought by lord Bacon, and others, to be the only food of plants; but a famous experiment of Van Helmont, usually brought to prove this, is nothing to the purpose, for the water contains earth, and, therefore, is never given to a plant as water alone.

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[1] No. XV.

Air, on account of its elasticity, is necessary to the increase of plants; but it does not follow, that it is the matter of that increase, although Bradley and others have taken great pains to prove that it is so. The experiments of Dr. Priestley, indeed, render it a natural conclusion, as mentioned in my paper above referred to, that phlogiston is the principal food of plants, upon which their nourishment and increase very much depend. As to fire, we are very well assured, that no plant can live without heat; but, although different degrees of heat are necessary to different plants, yet none can live in actual fire; nor has fire been ever thought the food of plants, except by Mr. Lawrence, and some of the metaphysicians. Others maintain, that earth alone is the true food and matter of increase in plants. Every plant, say the advocates for this opinion, is *earth;* and the growth and increase of that plant is only the addition of more earth to it, in the same form. They add, that nitre, and other salts, as those of dung, &c. prepare, attenuate, and divide the earth, destined for the increase of vegetables: that water and air move it, by conveying, and fermenting it in the juices; but that earth itself is still the food. When the additional earth is once assimilated to the plant, it becomes, they assert, a part of it, and remains for ever with it; but let water, air, and heat be taken away, and the plant remains a plant still, although a dead one. They add further, that the excess of the other things is a proof, that they are not the proper food of the plant, by destroying, instead of nourishing it: for too much nitre, or other salts, corrodes and kills the plant; too much water drowns it; too much air dries the roots of it; too much heat burns it; but too much earth a plant can never have, unless entirely buried under it, so as to exclude the necessary action of the rest of the assistant articles.

But how ingenious soever these arguments may be, more modern experiments and observations have led the way to another theory with respect to the food of plants, which seems to be less exceptionable than either of the theories I have stated. The sentiments of the illustrious Dr. Hales I have already mentioned in my former paper; in which I likewise intimated, what I shall now proceed to explain more particularly, the principle to which Dr. Hunter has had recourse. This gentleman, so justly celebrated, both as an anatomist and a natural philosopher, was induced by a number of experiments to conclude, that all vegetables receive their principal nourishment from oily particles incorporated with water, by means of an alkaline salt, or absorbent earth. Till oil is made miscible, it is unable to enter the radical vessels of vegetables; and, on that account, Providence has bountifully supplied all natural soils with chalky or other absorbent particles; and those soils which have been assisted by art are full of materials for that purpose; such as lime, marl, soap-ashes, and the volatile alkaline salt of putrid dunghills. Natural soils receive their oily particles from the air or atmosphere, which, during the summer months, is full of putrid exhalations from the steam of dunghills, the perspiration of animals, and smoke; and every shower brings down these oleaginous particles for the nourishment of plants. All rich soils, in a state of nature, contain oil; and, in lands that have been ploughed for some years, it is found in proportion to the quantity of putrid dung that is laid upon them, allowance being made for the crop they have sustained. By attending to the effects of manures of an oily nature, Dr. Hunter apprehends that we must be satisfied, that oil, however modified, is one of the chief instruments of vegetation. Thus rape-dust, laid on land, is a certain and speedy manure; as it contains the food of plants ready prepared. Soot is also an oily manure, but different from the former, because it contains alkaline salt, in its own nature calculated as well for opening the soil, as for rendering the oily parts miscible with water. The dung of pigeons, which feed chiefly upon grains and oily seeds, is a rich and quick manure. The dung of horses that are kept in stables, and fed upon beans, oats, and hay, which contain much oil, is also a strong manure, more especially when it has undergone the putrid ferment, in order to mix and assimilate its oily, watery, and saline parts. Swine's dung is of a saponaceous and oily nature, and the richest, perhaps, of all the oily manures. The dung of ruminant animals, as cows and sheep, is preferable to that of horses at grass, owing to the quantity of animal juices mixed with their food in chewing; and the fatter the animal, the richer is the dung. Human ordure, which is full of oil and a volatile alkaline salt, is of itself too strong a manure for any land. The dung of carnivorous animals is plentifully stored with oil; animals that feed upon seeds and grains come next; and after them follow those that subsist upon grass only.

The argument, moreover, in favour of oil being the principal food of plants, is confirmed by the observation, that all vegetables, whose seeds are of an oily nature, are found to be remarkable impoverishers of the soil; as hemp, rape, and flax: and the best manures for lands worn out by these crops are such as have a good deal of oil in their composition, provided that they are laid on with chalk, lime, marl, or soap-ashes, so as to render the oily particles miscible with water.

It must be further observed, that oily particles constitute the nourishment of plants in their embryo state; and, by a fair inference, we may suppose, that something of the same nature is continued to them as they advance in growth. The oily seeds, as rape, hemp, line, and turnip, consist of two lobes, which, when spread upon the surface, form the seminal leaves: in these the whole oil of the seed is contained. The moisture of the atmosphere penetrates the cuticle of the leaves, and mixing with the oil, constitutes an emulsion for the nourishment of the plant. The oleaginous liquor being consumed, the seminal leaves, having performed their *office*, decay. The leguminous and farinaceous plants keep their *placenta*, or seminal leaves, within the earth; in which situation they supply the tender germ with oily nutriment, until its roots are grown sufficiently strong to penetrate the soil.

It has been a received opinion, that lime enriches the land upon which it is laid, by supplying it with a salt fit for the nourishment of plants; but by all the experiments that have been made upon lime, it is found to contain no kind of salt. Its operation, therefore, should be considered different: by the fermentation which it occasions, the earth is opened and divided; and, by its absorbent and alkaline quality, it unites the oily and watery parts of the soil. It seems also to have the property of collecting the acid of the air, which it readily forms into a neutral salt, of great use in vegetation. It is probable, therefore, that lime tends to rob the soil of its oily particles, and will, in time, render it barren, unless care be taken to support it with rotten dung, or other manures of an oily nature. Its great excellence, upon a sandy soil, is by mechanically binding the loose particles, and thereby preventing the liquid parts of the manure from escaping out of the reach of the radical fibres of the plants. Upon clay its effect is different; for, by the gentle fermentation it produces, the unsubdued soil is opened and divided; the manures laid on readily come into contact with every part of it; and the fibres of the plants have full liberty to spread themselves. Clay, well limed, will fall in water, and ferment with acids; and, in these circumstances, the air, rains, and dews are freely admitted, and the soil is unable to retain the nourishment which they respectively afford. In consequence of a fermentation raised in the soil, the fixed air is set at liberty, which promotes *vegetation* in a surprising manner.

I have already observed, in my former paper, that to this universal principle of oil, Dr. Hunter adds another, which is the nitrous acid of the air; for, although experiments have not yet confirmed the efficacy of nitre, considered as a manure, he regards it as a vivifying principle in the process of vegetation.

In order to conceive how plants receive their nourishment, we must recur to the analogy that is known to subsist between plants and animals. Oil and water seem to make up the nourishment of both. Earth enters very little into the composition of either. It is known that animals take in a great many earthy particles at the mouth, but they are soon discharged by urine and stool. Vegetables take in the smallest portion imaginable of earth; and the reason is, that they have no way to discharge it. It is highly probable, that the radical fibres of plants take up their nourishment from the earth, in the same manner that the lacteal vessels absorb the nutriment from the intestines; and as the oily and watery parts of our food are perfectly united into a milky liquor, by means of the spittle, pancreatic juice, and bile, before they enter the lacteals, we have all the reason imaginable to keep up the analogy, and suppose that the oleaginous and watery parts of the soil are also incorporated, previous to their being taken up by the absorbing vessels of the plant. To form a perfect judgment of this, we must recollect, that every soil, in a state of nature, has in itself a quantity of absorbent earth, sufficient to incorporate its inherent oil and water; but when we load it with fat manures, it becomes essentially necessary to bestow upon it, at the same time, something to assimilate the parts. Lime, soap-ashes, kelp, marl, and all the alkaline substances, perform that office. In order to render this operation visible to the senses, dissolve one drachm of Russian potash in four ounces of water; then add one spoonful of oil; shake the mixture, and it will instantly become a uniform mass of a whitish colour, adapted to all the purposes of vegetation. This easy and familar experiment is a just representation of what happens after the operation of *burn-baking*, and, consequently, may be considered as a confirmation of the hypothesis advanced. In this process, the sward being reduced to ashes, a fixed alkaline salt is produced; the moisture of the atmosphere soon reduces that salt into a fluid state, which, mixing with the soil, brings about a union of the oily and watery parts, in the manner demonstrated in the experiment. When the under stratum consists of a rich vegetable mould, the effects of burn-baking will be lasting; but when the soil happens to be thin and poor, the first crop frequently suffers before it arrives at maturity. The farmer, therefore, who is at the expense of paring and burning a thin soil, should bestow upon it a portion of rotten dung, or shambles manure, before the ashes are spread, in order to supply the deficiency of oily particles: in this way, the crop will be supported during its growth, and the land will be preserved in health and vigour. Vegetables that have a succulent leaf, such as vetches, peas, beans, and buck-wheat, draw a great part of their nourishment from the air, and, on that account, impoverish the soil less than wheat, oats, barley, or rye, the leaves of which are of a firmer texture. Rape and hemp are oil-bearing plants, and, consequently, impoverishers of the soil; but the former less so than the latter, on account of the great succulency of its leaf. The leaves of all kinds of grain are succulent for a time, during which period the plants take little from the earth; but as soon as the ear begins to be formed, they lose their softness, and diminish in their attractive power. The radical fibres are then more vigorously employed in extracting the oily particles of the earth, for the nourishment of the seed. Dr. Hales observes, that the leaves of plants serve, not only as excretory ducts, to separate and carry off the redundant watery fluid, which, by being long detained in the plants, would turn tumid and prejudicial to them; but likewise to imbibe the dew and rain, which contain salt, sulphur, &c. and to be of the same use to plants that the lungs are to animals. He adds, however, that as plants have not a dilating and contracting thorax, their inspirations and expirations will not be so frequent as those of animals, but depend entirely on the alternate changes from hot to cold for inspiration, and *vice versâ* for expiration. But the greater part of their nourishment is derived from their roots[1]. These, therefore, are found to bear a considerable proportion to the body of the plant above ground; the superficies of the former being above four tenths of that of the latter. Hence appears the necessity of cutting off many branches from a transplanted tree; because, in digging it up, a great part of the roots is cut off.

The facts which I have stated above, with regard to the influence of putrid air, arising from dunghills, &c. on the nourishment and increase of plants, were published by Dr. Hunter, in his Georgical Essays in 1769 and 1770; and they were afterward ascertained in the most satisfactory manner, by a variety of subsequent experiments by Dr. Priestley; which led that great philosopher to the discovery of the grand restorative of vitiated air, of which, in my paper before referred to, I have given a particular account.

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[1] See No. XXVIII. Reflections on Vegetation.

No. XXV.

ON FLOWERS.

It Ver, et Venus, et Veneris prænuntius ante
Pennatus graditur Zephyrus vestigia propter:
Flora quibus mater præspergens ante viaï
Cuncta coloribus egregiis et odoribus opplet.
LUCRETIUS.

Propitious Spring comes forth in bright array,
With Venus, goddess of the vernal day:
Her mild precursor, Zephyr, wafts the breeze,
With balmy wings, o'er all the budding trees;
Maternal Flora, with benignant hand,
Her flowers profusely scatters o'er the land:
These deck the vallies with unnumbered hues,
And far around their fragrant sweets diffuse.

TO whatever part of the creation the Contemplative Philosopher may direct his view, he will ever find something productive of pleasure and instruction. Nature exhibits an infinity of objects, which, in beautiful succession, at once excite and gratify our natural ardour for variety. Not only each season of the year, but each part of the day, is productive of pleasures peculiar to itself. While the sun enlightens our horizon, with what unspeakable beauties does the landscape glow! How sweet the glittering dews, the woodland hymns, and brightening verdure of the morn! How delightful the meandering streams, the ruminating herds, and all the flowery beauties of the meads, beheld from some shady recess, in the radiant height of noon! What pleasure in the social, or the solitary walk, when the evening sun descends with mitigated ray, and the western sky is arrayed in such inimitable magnificence of tints! And when the shades of night prevail, the milder glories of a moonlight scene, with all the starry heavens, shed their peculiar influence, and, with the sensations of pleasure, excite the grateful effusions of wonder and adoration. But these are delights for which the gay advocates of licentiousness and dissipation can have no taste. They are reserved, as the sweetest charm of life, for those superior minds that delight to improve and perfect the habits of virtue, by the constant pursuit and acquisition of intellectual and moral excellence.

These grateful share the gifts of Nature's hand;
 And in the varied scenes that round them shine,
(The fair, the rich, the awful, and the grand)
 Admire th' amazing workmanship divine.

Blows not a flow'ret in th' enamelled vale,
 Shines not a pebble where the riv'let strays,
Sports not an insect in the spicy gale,
 But claims their wonder and excites their praise,

For them ev'n vernal Nature looks more gay,
 For them more lively hues the fields adorn;
To them more fair the fairest smile of day,
 To them more sweet the sweetest breath of morn.

They feel the bliss that Hope and Faith supply;
 They pass serene th' appointed hours that bring
The day that wafts them to the realms on high,
 The day that centers in eternal spring. T. SCOTT.

The great progenitor of the human race, when first conscious of existence, beheld in all aror him the most exquisite assemblage of rural be The very name of *Eden*, the delicious pa in which he was placed by the beneficent Cr signifies *pleasure*; and the idea of pleasure is inseparable from that of a garden, in which man still seeks the happiness he has lost, and in which, perhaps, a good man may find the nearest resemblance to it that this world can afford. Hence it has been very justly observed, that the love of woods, of fields and flowers, of rivers and fountains, seems to be a passion implanted in our natures the most early of any, even before the fair sex had a being.

> Flowers, the sole luxury which Nature knew,
> In Eden's pure and guiltless garden grew—
> Gay without toil, and lovely without art,
> They sprung to cheer the sense, and glad the heart.
>
> BARBAULD.

I have ever considered flowers as the pride and glory of the creation, and the most beautiful display of Matchless Power in the vegetable kingdom. With the poets too, as the lovely attendants of Spring, they are inexhaustible sources of decoration. Not only their favourite scenes, but the incidents which they are most fond to embellish, are enriched with flowers. Thus Virgil makes the swain invite Galatea to the spot, where Spring strews the riverbank with flowers[1]. Homer, to adorn the bed of Jupiter, makes the Earth pour from her bosom unbidden herbs, and voluntary flowers[2]. Milton, in a fine imitation of that passage, employs the iris, jessamine, and rose, the violet, hyacinth, and crocus, to beautify the blissful bower of Eve[3]. When our first parents take their evening repast, they recline on the soft downy bank damasked with flowers[4]. When Adam awakes Eve in the morning, it is with a voice mild as when Zephyrus breathes on Flora[5].

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[1] Ecl. ix. [2] Iliad. b. xiv. [3] Par. Lost, b. iv.
[4] Ibid. [5] Par. Lost, b. 5.

l when he invites her to walk forth in the fields,
to mark how the tender plants spring, how Na-
plants her colours, and how the bee sits on the
m, extracting liquid sweets[1]. Shakspeare, in a
rming similitude, compares an exquisite strain of
ic, with its dying fall, to the sweet South, that
athes upon a bank of violets, stealing and giving
ur[2]. And, to mention no more, Thomsom, in
noble hymn at the conclusion of the Seasons, in-

Par. Lost. b. v. See also his Lycidas, for a beautiful
cription of flowers.

Twelfth Night. act 1. See also his Winter's Tale.
modern poet has furnished us with a pleasing de-
ption of flowers:—

> Then the flowers on all their beds—
> How the sparklers glance their heads!
> Daisies with their pinky lashes,
> And the marigold's broad flashes,
> Hyacinth with sapphire bell
> Curling backward, and the swell
> Of the rose, full-lipped and warm,
> Round about whose riper form
> Her slender virgin-train are seen
> In their close-fit caps of green:
> Lilacs then, and daffodillies;
> And the nice-leaved lesser lilies
> Shading, like detected light,
> Their little green-tipt lamps of white:
> Blissful poppy, odorous pea,
> With its wing up lightsomely;
> Balsam with his shaft of amber,
> Mignonette for lady's chamber,
> And genteel geranium,
> With a leaf for all that come;
> And the tulip, tricked out finest,
> And the pink, of smell divinest;
> And as proud as all of them
> Bound in one, the garden's gem,
> Hearts-ease, like a gallant bold,
> In his cloth of purple and gold.—
>
> *Hunt's Descent of Liberty*, pp. 28, 29.

vites the flowery race to join in the general chorus of praise to the great Creator:

> Soft roll your incense, herbs, and fruits and flowers,
> In mingled clouds to Him, whose sun exalts,
> Whose breath perfumes you, and whose pencil paints.

I shall wave, at present, a scientific inquiry into the structure, parts, and properties of flowers, in order to introduce some reflections on their order of succession, and infinite variety. The attentive observer will perceive, that every plant upon earth appears in its appointed order. The God of Seasons, the God of Beauty and Excellence, hath exactly determined the time when *this* flower shall unfold its leaves, *that* spread its glowing beauties to the sun, and a *third* hang down its drooping head, and, withered, 'resign its sunny robes.' Long before the trees venture to unfold their leaves, and while Winter yet maintains his dreary reign, the snowdrop displays its milk-white flowerets to the eye:

> First leader of the flowery race aspires,
> And foremost catches the sun's genial fires,
> Mid frosts and snows triumphant dares appear,
> Mingles the seasons, and leads on the year.
>
> TICKELL.

Next appears the crocus, too timid yet to resist the impetuosity of the winds. With this comes the fragrant violet, the expressive emblem of that retiring goodness, which, with unostentatious hand, contributes silently to the happiness of all around. The polyanthus, too, with countless colours, and the auricula, inestimable for the exquisite richness of its powdered tints, demand the skilful culture of the florist. These, with many others which grow in foreign countries, upon the mountains, may be called, without impropriety, the vanguard of the flowery host.

These beauteous children of Nature do not appear all at once, but in the most enchanting regularity of succession. Each month displays the beauties peculiar to itself. Soon succeeds the tulip, the transient glory of the garden; the anemone, encircled at the bottom with a spreading robe, and rounded, at the top, into a beautiful dome; and the ranunculus, which displays all the magnificence of foliage, and charms the eye, with such a brilliant assemblage of colours. Nor lingers behind the rose, the favourite flower of poets, which glows with its own vivid tints, and diffuses around its aromatic sweets;—yet this rose, one of the greatest ornaments of our garden, ‘the sweetest flower’

That ever bloomed in any bower,

like the rest of its sister tribe, and that beauty of which it is so often mentioned as an emblem quickly hastens to decay:—

Poore silly flowre!
Though in thy beauty thou presume,
And breath which doth the spring perfume;
Thou may'st be cropt this very houre.

And though it may
Then thy good fortune be, to rest
O'th' pillow of some ladie's brest;
Thou'lt wither, and be throwne away.

For 'tis thy doome
However, that there shall appeare
No memory that thou grew'st heere.
Ere the tempestuous winter come.

HABINGTON.

The carnation, as if centering in itself the perfection of every flower next attracts the wanderer, by that lustre and variety of hues, and that fragrancy of scent, which entitle it to a kind of preeminence over the most beautiful of the painted tribes. But not to proceed with the later flowers of the year, I will conclude my observations on this head with Thomson's picturesque recapitulation:

At once arrayed
In all the colours of the flushing year,
By Nature's swift and secret-working hand,
The garden glows, and fills the liberal air
With lavish fragrance.

* * * * *

Along these blushing borders bright with dew,
And in yon mingled wilderness of flowers,
Fair-handed Spring unbosoms every grace;
Throws out the snowdrop, and the crocus first;
The daisy, primrose, violet darkly blue,
And polyanthus of unnumbered dies;
The yellow wall-flower, stained with iron-brown;
And lavish stock that scents the garden round;
From the soft wing of vernal breezes shed,
Anemonies; auriculas, enriched
With shining meal o'er all their velvet leaves;
And full ranunculus of glowing red.
Then comes the tulip race, where Beauty plays
Her idle freaks: from family diffused
To family, as flies the father-dust,
The varied colours run; and, while they *break*
On the charmed eye, the exulting florist marks,
With secret pride, the wonders of his hand.
No gradual bloom is wanting; from the bud,
First-born of Spring, to Summer's musky tribes:
Nor hyacinth, of purest virgin white,
Low bent, and, and blushing inward; nor jonquils,
Of potent fragrance; nor Narcissus fair,
As o'er the fabled fountain hanging still;
Nor broad carnations, nor gay-spotted pinks;
Nor showered from every bush, the damask-rose.
Infinite varieties, delicacies, smells,
With hues on hues expression cannot paint,
The breath of Nature, and her endless bloom.

What an inexhaustible source of grateful admiration does this regular succession of flowers present! What manifest displays of Divine Wisdom and ever *active* Goodness! Were all the flowers of the different seasons to bloom together in one gay assemblage, we should sometimes be overpowered with profusion, and at other times lament a total privation. Scarce should we be able to discern one half of their innumerable beauties, when the eye, with unspeakable regret, would witness their decay. But while its proper time and place is allotted to every kind of flower, this delightful succession enables us to contemplate them with greater convenience and exactness. We can often repeat the pleasing examination, enjoy all their beauties at our leisure, and form a more intimate acquaintance with them. This wise arrangement of Providence affords us another inestimable advantage. We not only view the various kinds of flowers, as they flourish, in the most beautiful perfection, but we become less sensible on this account of their transient duration. The early flowers flourish awhile and wither; but a variety of new kinds is constantly springing up, to prolong the beauty of the garden, and, as it were, to perpetuate our pleasure.

The infinite variety of flowers is not less a subject of admiration than their regular succession, and equally evinces consummate wisdom and design. Had there been an exact uniformity in the structure, form and colour, the fragrancy and other properties of flowers, that uniformity would have become fatiguing, and we should soon have languished for the charms of novelty. Or if the summer were to be productive of no other flowers than what adorn the spring, we should not only become weary of contemplating them, but neglect to bestow upon them the necessary care of cultivation. The Divine Goodness is indeed apparent, in having diversified the productions of the vegetable kingdom in such a delightful manner, as to add to their perfections the charms of a variety ever pleasing and ever new. This diversity is not discernible only in the different families of flowers, but it is to be seen, moreover, in the individuals. While the carnation is different from the tulip, and the tulip from the auricula; each carnation, each tulip, and each auricula has its peculiar character, with its particular beauties and varieties. In each there is something original. In a bed of tulips or carnations, there is scarce a flower in which some difference may not be observed in its structure, size or assemblage of colours; nor can any two flowers be found in which the shape and shades are exactly similar.

Some flowers rear their lofty heads, as if in proud pre-eminence over others, that rise to a moderate height, or keep their humble station near the ground. Some glow with the most gaudy colours, while others charm the eye with their elegant simplicity. With what masterly skill are the varying tints disposed; magnificently bold in some; in others delicately faint; laid on in *these* with a kind of negligence, and adjusted in *those* by the nicest touches of art! Some perfume the air with the most exquisite odours; while others are content to delight the eye, without gratifying the sense of smell. In fine, we behold that successive beauty, that pleasing variety, and that endearing novelty in flowers, in comparison of which all the works of art must appear insipid and disgusting.

Flowers, it may be supposed, have not only furnished the poets, as I have before observed, with inexhaustible description, but the philosophers in every age with a variety of moral sentiments. But reflections of this kind will lead me too far: I shal therefore conclude this paper with some beautiful lines, which I have selected, in particular, for the instruction of my fair readers.

Ye lovely Fair, while flowery chaplets bind
Your youthful brows, and o'er the verdant paths
Of gently-gliding life, ye graceful sweep,

Arrayed in purple pride; as on your breast
The diamond shines, and in your floating train
The ruby glows, and emeralds around
Beset the flying robe; while dazzling thus
In orient pomp, forgive if yet the Muse
In moralizing strains essays to draw
The evening veil o'er all the glittering show.
Vain is their blaze, which, like the noontide day,
Dazzles the eye: so flaunt the gaudy flowers
In vernal glory, wide diffusing round
Their odoriferous sweets, and shoot profuse
Their blossoms forth, and flourish in their May,
In Nature's livery clad; but when the sun
Beams in his pride, they droop their blushing heads,
Their blossoms wither, and their varied tints
Fade with his sultry rays. Behold, ye Fair,
Your gay delusions; read in Nature's book
Their transitory life, how quickly fleets
The dream of pleasure——
So beauty fades, so fleets its showy life,
As droops the lily, clad in all its pride
Of rich array.—— ANON.

No. XXVI.

THE ANATOMY OF FLOWERS.

Go, mark the matchless workings of the Power
That shuts within the seed the future flower;
Bids these in elegance of form excel,
In colour these, and those delight the smell;
Sends Nature forth, the daughter of the skies,
To dance on earth, and charm all human eyes.
COWPER.

IN my former paper I considered the subject f flowers in a poetical, philosophical, and moral ew; deducing such reflections from their order of ccession, their exquisite beauty, and infinite variety, as might impress the thinking mind with the love and veneration of that Great Being, who, in the most minute parts of his creation, displays such wisdom and benevolence. But if such wisdom and benevolence appear in the exterior decoration of flowers, what superior subjects of admiration will the Contemplative Philosopher discover, when he examines their constituent parts or what may properly be called, the Anatomy of Flowers. In every part he will find a wonderful harmony and concurrence of design, subservient to every end for which the whole was created, and incessantly productive of it.

Before I proceed in this examination of the constituent parts of flowers, it will be necessary to observe, that the modern system of botany, invented by Sir Charles Linné, is called the Sexual System; it being found on a discovery, that there is in vegetables, as well as in animals, a distinction of sexes. This doctrine was very imperfectly known to the ancients. The generality of flowers have been discovered to be hermaphrodite, that is, to contain within them, the characters of both sexes: in one class of vegetables the sexes are divided, and allotted to different flowers on the same plant; in another class, the male flowers grow all upon one plant, and the female upon another. This last circumstance did not escape the observation of the ancients. From the palm-tree, the fruit of which was held in great estimation, they could not but learn, that as the male flowers were upon one tree, and the female upon another, the flowers of the male were necessary to ripen the fruit of the female. That their practice was conformable to this idea, is evident from the account which Herodotus gives, in his first book, of the country about Babylon. The palm-trees there were universally an object of cultivation; and it was common for the inhabitants to assist the operations of Nature, by gathering the flowers of the male trees, and conveying them to the female. Thus they secured the ripening of the fruit, which otherwise, from unfavorable seasons, or the want of a proper intermixture of the trees of each sex, might have been precarious, or greatly deficient at least in the expected quantity.

It is rather surprising that this discovery did not lead the ancients, acute and penetrating as they were, to discover the entire process of Nature in the propagation of the various species of vegetables; and yet it does not appear that they ever went beyond this obvious remark upon the palm-tree, and some similar ideas concerning the fig. Indeed, from what they saw of these plants, they had conceived an opinion, that all other plants were likewise male and female; but this opinion was groundless, the far greater part of plants having hermaphrodite flowers. It is evident, therefore, that what they discovered of the palm and fig was only a just conjecture, but not founded on any knowledge of the anatomy of flowers, either in those trees, or in any others.

The doctrine of the sexes of vegetables continued in this obscure state almost to the end of the 17th century; so many ages having passed away before the moderns were more enlightened in this respect than the ancients. The honour of having first suggested the true sexual distinction in plants is due to Sir Thomas Millington, the learned Savilian professor; from whose hints Dr. Grew was led to his observations on this subject, in his Anatomy of Plants, published in 1682. After this, Moreland and Bradley, among the English; Camerarius and Blair among the Scots; and Geoffroy, Vaillant, and Jussieu, among the French; pursued their researches and experiments with such success, as to ascertain this discovery beyond the possibility of doubt. And, finally, Sir Charles Linné, the celebrated Swede, founded on this discovery that system of botany which is now universally received.

Agreeably to this system I shall now proceed to treat of the constituent parts of a perfect flower. Of these, which are seven in number, the first is called the calyx, empalement, or cup. It is the termination of the outer bark of the plant, which, after accompanying the trunk or stem through all its branches, breaks out with the flower. It has received different appellations, according to the circumstances with which it is attended. In the rose, and some other flowers, the calyx consists of those outside green leaves which inclose the flower in the bud. In others, it consists of one funnel-like cup, as in polyanthuses aud auriculas. In corn or grass, it is called the husk. In the willow or filbert, it forms the catkins, or that assemblage of imperfect flowers which hangs from the tree in the manner of a rope, or cat's tail. In all these varieties the use of the empalement is to defend the young tender flower while yet in its blooming state. But flowers that are very robust, as the tulip, crown-imperial, and lily, have no empalement.

The second object in the structure of flowers is the corolla, or foliation, which is the termination of the inner bark continued to, and accompanying, the fructification, in this new form of painted leaves. The leaves of which the corolla consists, are called petals, to distinguish them from the green leaves of the plant with which they might otherwise be confounded. Linné defines the petal to be a corolaceous covering to the flower; meaning that it incloses and protects it in the manner of a corolla or wreath. In these petals, which constitute the most conspicuous part of the flower, not only the most exquisite beauty and luxuriant colours are observable, but also the very curious manner in which they are folded in the empalement, before they are expanded. The use of the corolla is the same as that of the calyx, serving as an inner work of defence for the parts it incloses, as the calyx, which is usually of a stronger texture, does for an outer one.

Among the varieties observable in the corolla, there is one part, called the nectarium, which has been but recently distinguished, having been confounded by former botanists with the petals. Linné defines it to be the part which bears the honey, and belonging to the flower only. This part affords a wonderful variety in the manner of its appearance. In some plants it is very large, as in the daffodil and columbine; in the former of which the cup, and in the latter the horns, are nectaria. In others it is scarce discoverable even with glasses. In some plants it is united with, and makes part of the petals; in others, it is detached from them. Its shape and situation are also as various. Its use is not known, unless the supposition of its secreting the honey may be depended upon.

The stamina form the third constituent part in flowers. Linné defines them as an entrail of the plant, designed for the preparation of the pollen, otherwise called the farina fœcundans, or fertilizing dust. Each single stamen consists of two parts; first, the filament, or thread, vulgarly called the chive, which serves to elevate the anthera, apex, or summit, and at the same time connects it with the flower; secondly, the anthera itself, which contains within it the fertilizing dust, and, when come to maturity, discharges the same. The pollen is a fine dust, secreted within the anthera, and destined for the impregnation of the germen or bud. It is, indeed, the immediate organ of fertilization in the seed of plants, and where this is wanting to fertilize the seed, such seed will never produce a plant. A remarkable experiment to prove this occurs in the 47th volume of the Philosophical Transactions. There was a great palm-tree in the garden of the royal academy at Berlin, which flowered and bore fruit for thirty years, but the fruit never ripened, and when planted, it did not vegetate. The palm-tree, as before observed, is one of those in which the male and female parts of generation are upon different plants. There being no male plant in this garden, the flowers of the female were never impregnated by the farina of the male. At Leipsic, twenty German miles from Berlin, was a male plant of this kind, from which, in April 1749, a branch of male flowers was procured, and suspended over the female ones. This experiment was so successful, that the palm-tree produced more than a hundred perfectly ripe fruit, from which they had eleven young palms. On repeating the experiment, the next year, the palm-tree produced above 2000 ripe fruit.—This experiment fully establishes the fact, attested by the ancients, concerning the palm-tree, which some, perhaps, may have regarded as fabulous; and as the fructification in other vegetables, although it may differ in particular circumstances, has yet, in general, an evident conformity with that of the palm-tree, in respect to the parts supposed to be the organs of generation, which are discoverable either on the same, or on a separate flower, in all but one particular class, called Cryptogamia, in which they are too minute for observation; so, from this single experiment, an argument may be deduced by analogy, for the confirmation of the whole sexual hypothesis.

If we take one of these antheræ, or apices, from a sunflower, and view it through a microscope, we shall observe a great number of small yellow balls on each side of the apex, or summit, which is open on both sides. The surface of the apex will be observed almost covered with them. Those upon the concave will appear extremely beautiful, being spiculated all around; they will likewise be found to be perfectly globular, and of a fine yellow transparency. These balls contain a very subtle, pellucid, oily fluid, or spirit, which is easily observed when some of them are bruised upon the grass.—In a word, as the stamina, which thus includes the antheræ and the pollen, is the male part of the flower, wherever the stamina is wanting that flower is female.

The fourth part of a flower is the pistil, which is a very essential one, being the female part. Linné defines it to be an entrail of the plant, designed for the reception of the pollen. It consists of three parts; 1. the germen, or bud, which is the rudiment of the fruit accompanying the flower, but not yet arrived at maturity; 2. the style, which is the part that serves to elevate the stigma from the germen; and, 3. the stigma, which is the summit of the pistil, and covered with a moisture for the breaking of the pollen.

I have already observed, that the pollen was destined for the impregnation of the germen, which is thus performed: The antheræ, which, at the first opening of the flower, are whole, burst open soon after, and discharge the pollen; which dispersing itself about the flower, part of it lodges on the surface of the stigma, where it is detained by the moisture with which that part is covered; and each grain or atom of the pollen bursting and dissolving in this liquor, as it has been observed to do by the aid of the microscope, is supposed to discharge something which impregnates the germen below. What the substance is, that is so discharged, and whether it actually passes through the style into the germen, seems yet undetermined, it being difficult to observe such minute parts; but whatever be the operation by which Nature produces the effect in question, the cause, as far as it has been here explained, is scarce disputable; and accordingly we see, that after this impregnation, when the parts of the flower that have performed their office are fallen away, the germen swells to a fruit big with seed, by which the species is propagated. And thus, as wherever the stamina is wanting the flower is female; in like manner, wherever the pistil is wanting, the flower is male: such as have both, are called hermaphrodite, and such as have neither, neuter.

The fifth part of a flower is the pericarpium, or seed vessel, which is the germen grown to maturity. Linné defines it to be an entrail of the plant big with seed, which it discharges when ripe. They have several scientific names, corresponding to their respective natures, whether they be pods, legumes, nuts, apples, berries, &c.

The seed, which is the sixth part of a flower, is, according to the definition of Linné, the deciduous part of a vegetable, the rudiment of a new one, quickened for vegetation by the sprinkling of the pollen. It is the ultimate produce, yet incipient principle, of vegetative nature. It is the natural offspring of the flower, and that for whose production all its parts seem intended; so that when this is once well formed, the several parts of the flower dwindle and disappear.

The seventh and last part, is the receptacle, which is the base, that connects the other six parts of fructification.

From this account of the anatomy of flowers, it appears how very superficial is the judgment of those who imagine the study and cultivation of them beneath their notice. "I have been often surprised (says a fine writer) to find those who possessed a very acute susceptibility of artificial or literary grace, and were powerfully affected by the beauties of a poem, a piece of sculpture, or a painting, not at all more sensible of the charms of a tree, or a floweret, than a common or inelegant spectator. They have dwelt with rapture on a fine description of the vale of Tempe; they have entered into all the delight which a Shakspeare or a Milton meant to communicate, in their enchanting pictures of flowery and sylvan scenes, and yet can walk through a wood, or tread on a bank of violets and primroses, without appearing to be affected with any peculiar pleasure. This is certainly the effect of a superficial judgment; for there is no truth of which philosophers have been longer convinced, than that the realities of Nature infinitely exceed the most perfect productions of imitating art."—What then should be our sensations, when, to the display of unspeakable beauty in all, are added the great designs of unceasing and unbounded benevolence! But, not to carry this discussion to too great a length, I will conclude with the following animated lines from Thomson:

Who can paint
Like nature? Can Imagination boast
Amid its gay creation, hues like hers?
Or can it mix them with that matchless skill,
And lose them in each other, as appears
In every bud that blows? If Fancy then,
Unequal fails beneath the pleasing task,
Ah! what shall language do? Ah! where find words,
Tinged with so many colours; and whose power,
To life approaching, may perfume my lays
With that fine oil, those aromatic gales,
That inexhaustive flow continual round.

No. XXVII.

REFLECTIONS ON THE MODERN ART OF GARDENING.

> The love of Nature, and the scenes she draws,
> Is Nature's dictate. COWPER.

> Hail to the Art, that teaches Wealth and Pride
> How to possess their wish, the World's applause,
> Unmixt with blame! that bids Magnificence
> Abate its meteor glare, and learn to shine
> Benevolently mild.
> Gothic Pomp
> Frowns and retires, his proud behests are scorned:
> Now Taste, inspired by Truth, exalts her voice,
> And she is heard. MASON.

WHATEVER delight we find in contemplating the works of Art, whether magnificently great, or elegantly minute, nothing is more certain, than that Nature, in all her varieties of aspect, is still more irresistibly enchanting. The vulgar and uninformed, indeed, in the prospect of a fine country, look no farther than to the different scenes of cultivation; for they have seldom any other object of attraction than mere utility. The observations with which they are content, are, perhaps that the barley is fine, and the clover rich: observations which a mere quadruped would make with equal sagacity, were it endued with the gift of speech. But the ideas of the Contemplative Philosopher are more extensive and sublime. To culture, indeed, he gives the praise which it unquestionably demands; while he extends his enraptured eye to the spontaneous beauties of Nature, or to the happy improvements of them which assisting Art effects; and which, while they charm, not so much by distant prospect as by the beauties of diversified land-cape, afford the purest sources of elegant and irtuous pleasure.

The pleasures which arise from the observation f Nature are such, indeed, as must be highly greeable to every taste undepraved by culpable dulgence. Rural scenes, in particular, are de- ghtful to the mind of man. The verdant plains, e flowery meads, the shady woods, and winding eams; the ruminating herds, the playful lambs, e warbling birds, and even the rooks with harsh d discordant sound, are all capable of exciting e sweetest and most agreeable emotions. And t the greater part of mankind are hurried on so pidly in the pursuits of life, and so agitated by ntending passions, that they have neither leisure observe, nor a taste to admire objects so uncon- nial to their education, their habits, and their ishes. And with many, not only the palaces, but en the most gloomy habitations of the metropo- s, where riches may be acquired, have far more tractive charms than the most enchanting sce- ery of the country.

Strange! there should be found
Who self-imprisoned in their proud saloons,
Renounce the odours of the open field
For the unscented fictions of the loom;
Who, satisfied with only pencilled scenes,
Prefer to the performance of a God
Th' inferior wonders of an artist's hand.]
Lovely indeed the mimic works of Art,
But Nature's works far lovelier. I admire.
None more admires the painter's magic skill,
Who shows me that which I shall never see,
Conveys a distant country into mine,
And throws Italian light on English walls.
But imitative strokes can do no more
Than please the eye, sweet Nature every sense.
The air salubrious of her lofty hills,
The cheering fragrance of her dewy vales,

And music of her woods—no works of man
Can rival these: these all bespeak a power
Peculiar, and exclusively her own. COWPER.

O how canst thou renounce the boundless store
Of charms, which nature to her votary yields?
The warbling woodland, the resounding shore,
The pomp of groves and garniture of fields;
All, that the genial ray of morning gilds,
And all, that echoes to the song of even;
All, that the mountain's sheltering bosom shields,
And all the dread magnificence of heaven;
O how can'st thou renounce, and hope to be forgiven!
BEATTIE.

From these general observations on the natural beauties of the country, it is an easy step to those decorations of Art with which the man of true taste can enliven and improve even the charming scenes of Nature; and which, so far from excluding cultivation for mere decoration, or the useful for the agreeable, often happily associate them both. Thus in Thomson's fine description of the retirement of Sir Industry, in his Castle of Indolence, he has united culture and ornament, or, in other words, has given us a happy sketch of 'The modern Art of Gardening:'

Nor from his deep retirement banished was
Th' amusing care of rural industry.
Still, as with grateful change the seasons pass,
New scenes arise, new landscapes strike the eye,
And all th' enlivened country beautify:
Gay plains extend where marshes slept before;
O'er recent meads th' exulting streamlets fly;
Dark frowning heaths grow bright with Ceres' store,
And woods imbrown the steep, or wave along the shore.

As nearer to the farm you made approach,
He polished Nature with a finer hand:
Yet on her beauties durst not Art encroach,
'Tis Art's alone those beauties to expand.

In graceful dance immingled, o'er the land,
Pan, Paleas, Flora, and Pomona played:
Here, too, brisk gales the rude wild common fand[1]
A happy place; where free, and unafraid,
Amid the flowery brakes each coyer creature strayed.

The poets, in every age, have been enraptured with the beauties of a garden, how various soever their ideas of its constituent parts. The Elysian Fields, those sweet regions of poetry, are adorned with all that Fancy can imagine to be delightful. Homer describes the garden of Alcinous in the richest poetry; and Ovid wanders with rapture through his Thessalian Tempe. Lucan is represented by Juvenal as reposing in his garden. Horace prayed for a villa where there was a garden, a rivulet, and a grove; and Virgil languished for the enjoyment of rivers and woods, and the cool vallies of Mount Hæmus. 'Of all my works,' said Pope, 'I am most proud of my garden.' And the great, the profound Descartes, whose mind was, at all times, in a state of perpetual serenity, amused his summer evenings in the cultivation of a small garden, which was an appendage to his house at Amsterdam. Thus, as his biographer finely remarks, having settled the place of a planet in the morning, he would amuse himself, in the evening, by watering a flower! 'I look upon the pleasure, we take in a garden,' says that amiable and excellent man, who first brought philosophy from the schools, 'as one of the most innocent delights in human life. It is naturally apt to fill the mind with calmness and tranquillity, and to lay all its turbulent passions at rest. It gives us a great insight into the contrivance and wisdom of providence, and, suggesting innumerable subjects for meditation, I cannot but think, that the very complacency and satisfaction, which a man takes in these pleasures, is, in itself, a virtuous habit of the mind.'

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[1] Used by Spenser for *found*: it is still retained in Scotland.

Some of the most interesting and delightful passages in Milton, are those in which he represents the happy pair employed in cultivating their blissful abode. The love of our first mother for the products of nature is beautifully instanced in that passage of the eighth book, where Eve, perceiving the Angel and Adam about to enter into high and abstruse converse, rose from her seat and went forth,

> Among her fruits and flowers ;
> To visit how they prospered, bud and bloom
> Her nursery ; they at her coming sprung,
> And touched by her fair dalliance gladlier grew.

And when she learns, that she must quit that delightful Paradise, in which she had tasted so much happiness, how exquisitely beautiful and pathetic is her lamentation !

> ' Must I then leave thee, Paradise !—Thus leave
> Thee, native soil, these happy walks and shades,
> Fit haunt of Gods, where I had hoped to spend
> Quiet, though sad, the respite of that day,
> That must be mortal to us both ?—O flowers,
> That never will in other climate grow,
> My early visitation and my last
> At even, which I bred up with tender hand
> From the first opening bud, and gave you names !
> Who now shall rear you to the sun, or rank
> Your tribes, and water from the ambrosial fount ?—
> Thee, lastly, nuptial bower, by me adorned
> With what to sight or smell was sweet : from thee
> How shall I part ?—and whither wander down
> In a lower world, to this, obscure
> And wild ?—How shall we breathe in other air
> Less pure, accustomed to immortal fruits ?'

Tasso pictures Rinaldo sitting beneath the shade in a fragrant meadow : Virgil describes Anchises seated beneath sweet-scented bay-trees ; and Æneas as reclining, remote from all society, in a deep and winding valley. Gassendi, who ingrafted the doctrine of Galileo on the theory of Epicurus, took not greater pleasure in feasting his youthful imagination by gazing on the moon, than Cyrus, in the cultivation of flowers.—'I have measured, dug and planted, the large garden, which I have at the Gate of Babylon,' said that Prince; 'and never, when my health permit, do I dine until I have laboured two hours in my garden: if there is nothing to be done, I labour in my orchard.' Cyrus is also said to have planted all the Lesser Asia.—Ahasuerus was accustomed to quit the charms of the banquet to indulge the luxury of his bower; and the conqueror of Mithridates enjoyed the society of his friends, and the wine of Falernium, in the splendid gardens, which were an honour to his name. Dion gave a pleasure-garden to Speucippus as a mark of peculiar regard.—Linnæus studied in a bower; Buffon in his summer-house; and when Demetrius Poliorcetes took the Island of Rhodes, he found Protogenes at his palette, painting in his arbour. Petrarch was never happier, than when indulging the innocent pleasures of his garden. 'I have made myself two,' says he, in one of his Epistles: 'I do not imagine they are to be equalled in all the world: I should feel myself inclined to be angry with fortune, if there were any so beautiful out of Italy[1].'

Virgil, too, as appears from his Georgics, was not only highly captivated with rural scenes, but a great cultivator of them. In the fourth book of the Georgics he seems to lament, that the limits of his subject would not permit him to sing of gardens. He gives us pleasure, however, in a rapid and delightful sketch of horticulture, and the affecting episode of a venerable old man, happy in cultivating and adorning a few barren and forsaken acres. What the Roman poet regretted he could not do, was performed in the 17th century by father Rapin, who wrote a poem on gardens, in the language, and sometimes in the style of Virgil. But his poem, which is didactic, treats only of the mechanical part of the Art of Gardening. He has entirely forgotten the most essential part, that which seeks, in our sensations and sentiments, for the source of those pleasures which the beauties of Nature inspire, when improved and perfected by Art. In a word, his gardens are the gardens of the architect; but not the delicious haunts of the philosopher, the painter, and the poet.

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[1] See the Philosophy of Nature, Vol. I. pp. 111, 120.

Thomson, in his charming poem of the Seasons, has not been content with the most luxuriant descriptions of rural scenes, but has deduced from them the most sublime, moral, and religious themes. Shenstone transferred his fine poetical paintings to his few paternal acres, and made them flourish there in the most beautiful reality. And since his time, the abbé de Lille in France, and our countryman Mason, have published regular didactic poems on the modern Art of Gardening, in which they have enlivened the dryness of preceptive poetry by all the captivating powers

> Of 'music, image, sentiment, and thought,
> Never to die!'

Mr. Mason begins his admirable poem with an invocation to Simplicity, as the inseparable attendant on genuine beauty and unaffected grace. He likewise invokes the two sister arts of Poetry and Painting to promote a kindred art; an art in which the attributes of both are engaged.

Hence he considers the garden as a picture, the unadorned and naked soil as the painter's canvass, and all the means of decoration as the pencil and colours with which he is to work. The same idea is likewise beautifully expressed by the abbé de Lille:

Un jardin, à mes yeux, est un vaste tableau.
Soyez peintre. Les champs, leurs nuances sans nombre,
Les jets de la lumière, et les masses de l'ombre,
Les heures, les saisons, variant tour-à-tour,
Le cercle de l'année et le cercle du jour,
Et des prés émaillés les riches broderies,
Et des rians côteaux les vertes draperies,
Les arbres, les rochers, et les eaux, et les fleurs.
Ce sont là vos pinceaux, vos toiles, vos coleurs.

To me the garden a vast picture seems:
Be painter then. The ample fields around;
Their varying shades, unnumbered, that display
The vivid rays of light, or mass of gloom;
The hours, and seasons, and revolving still
The circle of the year and circle of the day;
The meads in variegated beauty bright;
The ever-cheering verdure of the hills;
The streams; the rocks; the rivers; and the flow'rs;
Thy pencils these, thy canvass, and thy tints.

Agreeably to this idea, the modern art of gardening has been justly styled an imitation of the Deity in the most beautiful of his visible works. The great elements of this species of beauty seem to be wood, water, and uneven ground; to which may be added a fourth, that is to say, lawn. It is the happy mixture of these four that produces every scene of natural beauty, as it is a more mysterious mixture of other elements, perhaps as simple and as few, that is productive of a world or a universe.

The painters seem to have felt the force of these elements, and to have transplanted them into their landscapes with such felicity, that they have rathe emulated than imitated nature. Claude Lorraine, the Poussins, Salvator Rosa, and a few more in the 17th century, may be called superior artists in this exquisite taste. Yet, with all their superiority to their contemporaries in landscape-painting, Lord Kames observes, that it requires more genius to paint in the gardening way. 'In forming a landscape upon canvass (says this elegant and philosophic writer) no more is required but to adjust the figures to each other; an artist who would form a garden in Kent's manner, has an additional task; which is, to adjust the figures to the several varieties of the field.'

But while the genuine beauties of Nature were displayed on the canvass, our gardens, till the 18th century, exhibited scenes, which, in every respect, were tasteless and insipid. The artists of those times imagined, that the farther they wandered from nature, the nearer they approached to the sublime. Unfortunately, where they travelled no sublime was to be found; and the farther they went the farther they left it behind. Perfection in no science whatever has been the work of a day. Many prejudices were to be removed; many gradual ascents to be made from bad to good, and from good to better, before the delicious amenities of a Claude or a Poussin could be rivalled in a Stourhead, a Hagley, or a Stow; or the tremendous beauties of a Salvator Rosa could be equalled in the scenes of a Piercefield or a Mount Edgecombe.

O how unlike the scene my fancy forms,
Did Folly, heretofore, with Wealth conspire
To plant that formal, dull, disjointed scene,
Which once was called a garden. Britain still,
Bears on her breast full many a hideous wound
Given by the cruel pair, when, borrowing aid
From geometric skill, they vainly strove
By line, by plummet, and unfeeling sheers,

To form with verdure what the builder formed
With stone. Egregious madness; yet pursued
With pains unwearied, with expense unsummed,
And science doating. Hence the sidelong walls
Of shaven yew; the holly's prickly arms
Trimmed into high arcades; the tonsile box
Wove, in Mosaic mode of many a curl,
Around the figured carpet of the lawn.
Hence too deformities of harder cure:
The terrace mound uplifted; the long line
Deep delved of flat canal; and all that Toil,
Misled by tasteless Fashion, could achieve
To mar fair Nature's lineaments divine.

Mr. Horace Walpole, in an ingenious essay on modern Gardening, has quoted several passages from Milton, full half a century before the appearance of Kent, the great reformer of gardening, to show that our divine bard had the justest and most perfect ideas of this beautiful art. But I will not repeat the observations of this lively writer, which are too copious to be quoted. The reader who would trace the gradual prospect of a more enlightened taste in gardening, and who would form a just idea of the reformation which Kent effected, will read Mr. Walpole's remarks with particular satisfaction. I shall be content to observe, that the art of gardening, which may be called the luxury of agriculture, appears to me one of the most becoming, and I had almost said, the most virtuous amusements of the wealthy. As culture, it recals them to the innocence of rural occupations: as decoration, it favours, without danger, that taste for expense which is so naturally attendant on great fortunes. And far superior are such pleasures to the ordinary pursuits of the great, in senates and in courts.

Could'st thou resign the park and play content,
For the fair banks of Severn or of Trent;
There might'st thou find some elegant retreat,
Some hireling senator's deserted seat;

And stretch thy prospects o'er the smiling land,
For less than rent the dungeons of the Strand;
There prune thy walks, support thy drooping flow'rs,
Direct thy rivulets, and twine thy bow'rs;
And while thy beds a cheap repast afford,
Despise the dainties of a venal lord:
There every bush with Nature's music rings,
There every breeze bears health upon its wings;
On all thy hours security shall smile,
And bless thy evening walk and morning toil.

JOHNSON.

No. XXVIII.

REFLECTIONS ON VEGETATION.

Your contemplation further yet pursue;
The wondrous world of vegetables view!
See various trees their various fruits produce,
Some for delightful taste, and some for use.
See sprouting plants enrich the plain and wood,
For physic some, and some designed for food.
See fragrant flowers, with different colours dyed,
On smiling meads unfold their gaudy pride.

BLACKMORE.

IN Spring, when Nature has again beautified the earth with the brightest colours, and universal life and cheerfulness pervade the whole creation, my inquiries are naturally directed to the great principle of vegetation, by which such a wonderful transformation has been effected. But the subject is too copious and too extensive to be treated of with systematic accuracy: I shall be content, therefore, to point out some of its most prominent and pleasing features to the contemplation and admiration of my readers.

The definition of a plant is the first object of inquiry. Boerhaave defines a plant to be an organical body, composed of vessels and juices; to which body belongs a root, or a part by which it adheres to some other body, and particularly the earth, from which it derives the matter of its life and growth. It is distinguished from a fossil by its being organized, and consisting of vessels and juices; and from an animal, by its adhering to another body, and deriving its nourishment from it.

That plants are organized bodies, and endued with life, is evident from a variety of considerations, and particularly, from a degree of spontaneous motion observable in them. Thus, herbs, in green-houses or stoves, incline toward the light: when shut up, if they find a hole in the wall, shutters, or frames, they will endeavour to penetrate. Several plants, in the day-time, turn their flowers toward the sun: most plants, in a serene sky, expand their flowers; but, before rain, shut them up, or contract them at the approach of night. The flowers of many plants hang down in the night, as if the plants were asleep, lest rain, or the moist air should injure the fertilizing dust. The trefoils, and others, shut up, or double their leaves before storms or tempests, but unfold them in a clear sky. The tamarind-tree is said by Alpinus and Acosta to infold within its leaves the flowers or fruit every night, in order to guard them from cold or rain. Some of the sensitive plants, and the wood-sorrel, with pinnated leaves, upon being touched, roll up their leaves, and turn downward or shrink, and after a little time expand them again, as if they had both life and sensation. And it further appears, that motion is no less necessary to the vigour of plants, than exercise is to the health and strength of animals. Thus plants, in stoves and greenhouses, although they have sufficient heat and nourishment, are slender and weak, lose the colour of their leaves, and seem to languish for want of motion. And trees surrounded by high walls or buildings, and confined within narrow bounds, are slender, and grow tall, but not strong. From the observations, moreover, of some celebrated naturalists, a great similarity appears between the mechanism of plants and that of animals; the parts of the former bear some analogy to those of the latter; and the vegetable and animal economy appear to be formed on the same model.

The structure of plants is next to be considered. The roots, stalk, branches, leaves, flowers, and fruit, comprise all that is most remarkable in their external parts. The roots, by means of their different kinds of hinges, tuberosities, and ramifications, keep the plant fixed to the earth; while their pores imbibe an exceedingly fine slime, which the water liquefies, and carries with it. From the root springs the stalk, to which the plant partly owes its strength and beauty. Being sometimes shaped like a pipe, the stalk is fortified by knots skilfully disposed. As it is sometimes too weak to support itself, it twists round a solid prop, fastening by means of the little hands with which it is furnished. In some it appears a strong pillar, rearing its proud head aloft in the air, and braving all the fury of storms and tempests.

The branches shoot forth like so many arms, from the trunk and stalk, on which they are distributed with great regularity. They are divided and subdivided into many small boughs; the subdivisions observing the same order as the principal divisions.

Those leaves, those charming ornaments of plants, are disposed round the stalk and branches with the same symmetry. Some are simple, others compound, or formed of various foliage. One sort is plain, another indented. Some of them are very thin; others hard, soft, plump, smooth, rough, hairy, &c.

The flowers, whose beautiful enamel is one of the principal glories of Nature, are not less diversified than the leaves. Some have only a single leaf, or petal; others several. Here it appears like a large vessel gracefully opening: there it forms some grotesque figure, in imitation of a muzzle, head-piece, or cowl. Here it is a butterfly, a star, a crown, a radiant sun. Some are scattered on the plant without any art: some compose nosegays, globes, tufts of feathers, garlands, pyramids, &c. The greater part of them are furnished with a calyx; sometimes plain and simple; sometimes consisting of several pieces, or properly cut. From the centre of the flower proceeds one or more little pillars, called pistils, which are either smooth or channelled, rounded at top, or terminating in a point. These commonly encircle other smaller pillars, called stamina, which carry on the upper part of them a sort of small bladders, full of an exceedingly fine powder, called the pollen, or fertilizing dust; every grain of which, viewed through a microscope, appears of a very regular figure, but varied according to its species. In some they are small smooth globes; in others they are thickly set with prickles, like the covering of a chesnut; and sometimes they resemble small prisms, or some other regular body. The flowers are succeeded by an infinite profusion of fruit and seed[1].

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[1] See No. XXVI. for an account of the Anatomy of Flowers, and the sexual system of plants.

All fruits and seeds have this in common, that they inclose under one or more coverings the germ of the future plants. Some have only such coverings as immediately infold the germ, whose outside is of the strongest contexture; and, among these, there are some that are provided with wings, tufts, plumes of feathers, &c. by means of which they are conveyed in the air or water, so as to be transported and sown in different parts. Others are better clothed: being lodged in seeds or pods, inclosed in a kind of box, having one or more partitions. A third sort, under a delicious fruit, which is rendered still more agreeable by its beautiful colour, contain a stone and kernel. Others are inclosed in shells, which are either armed with prickles, abound with a bitter juice, or are adorned with a very fine down or hair. The outside of fruits and seeds, moreover, do not afford less variety than that of the leaves and flowers, there being scarcely any figure whatever, of which they do not exhibit an exact representation.

Such are the exterior parts of plants: the internal are composed of four orders of vessels, namely, the ligneous fibres, the utriculi or little bags, the proper vases, and the tracheæ or air vessels.

The ligneous fibres are very small channels deposited according to the length of the plant, and consisting of little tubes placed near each other. Sometimes these vessels are parallel, and at others are separated, leaving between them intervals, or oblong spaces, which are filled by the utriculi, a kind of membraneous bladders, horizontally disposed, and communicating with each other. The proper vessels are a kind of ligneous fibres, that differ from the rest principally from their *juice,* which is of a deeper colour, or thicker.

In the middle of these, or round a great number of ligneous fibres, are some vessels, which are not so narrow, composed of a silvery elastic blade, formed spirewise, like a spring. These are arteries, and seldom contain any thing but air.

These four orders of vessels, which are dispersed through all the parts of the vegetable, in proportion to the nature and function of each, compose, at least in trees and shrubs, three principal and concentric beds, the bark, the wood, and the pith. The bark or rind, which is the outer covering, is smooth, even, and shining in some, and rough, chanelled and hairy in others: it is formed of the widest fibres, that are the least pressed together, and which admit within them the most air. The wood, which is placed under the rind, has, on the contrary, narrower and more contracted tubes. Its utricles are less replenished or dilated; and this only has arteries. The pith, which is situate in the heart of the plant, is little more than a collection of utricles, which are greater and more capacious than those of the bark and wood.

From the structure of plants we proceed to their nutrition, by their roots and leaves. The saline, unctuous, and subtile slime, which the water separates from the coarse earth, and keeps in a dissolved state, is the principal nutriment of plants. The different species of manure only contribute to the fertilizing of land, in proportion as they introduce into it a greater quantity of a spongy powder or active salt[1].

After having been admitted into the body of the root by the extremity of the fibres, the nutritious juice rises into the ligneous fibres from the trunk or stalk, and passes into the utricles that adhere to them. It is there prepared and digested. It afterward enters into the proper vessels, under the form of a coloured fluid more or less thick, which we may conjecture to be with respect to the plant, what the chyle or blood is to the animal. Being filtered by the finer or more winding tubes, it is at last conveyed to all the parts, to which it unites, and increases their bulk.

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[1] *See No.* XXIV. On the Food of Plants.

The quantity of nutriment which a plant derives from the earth is in proportion to the number and size of its leaves; the smaller and fewer in number the leaves are, the less it draws.

The nutrition of végetables is likewise effected immediately by their leaves. They not only serve for raising the sap, preparing it, and discharging its superfluity, but they are a kind of roots that pump from the air the juices they transmit to the neighbouring parts. The dew, which arises from the ground, is the principal foundation of this aërial nourishment. The leaves present to it their inferior surface, which is always furnished with an infinite number of small pipes that are always ready to absorb it. And that the leaves may receive no prejudice in the exercise of this function, they are dispersed with such art on the stalk and branches, that those which immediately precede, do not cover such as succeed them. Sometimes they are placed alternately on two opposite and parallel lines. Sometimes they are distributed by pairs, that cross each other at right angles. Sometimes they are ranged on the angles of polygons circumscribed on the branches, and so disposed, that the angles of the inferior polygon correspond with the sides of the superior. And sometimes the leaves ascend the whole length of the stalk and branches, in one or more parallel spiral lines.

By a mechanism, which is doubtless very simple, the root of the plant forces itself into the earth, the branches shoot out on each side, the leaves expose their superior surface to the open air, and their inferior surface to the earth, or the inner part of the plant. If a seed be sown the contrary way, the radicle and the little stalk will each bend backward; the former, in order to penetrate into the earth, and the latter to gain the air. If a young stalk be kept inclined, its extremity, notwithstanding, will grow upright. Bend the branches of all sorts of plants; cause the inferior surfaces of their leaves to turn toward the sky; you will soon perceive that all these leaves will resume their former position.

Many great naturalists have supposed a circulation of the sap in plants; but Dr. Hales has demonstrated, that the sap does not circulate, but that it *ascends* and *descends*. In order to understand the motion of the sap, according to his principles, it is to be considered, that during the heat of a summer's day, all plants perspire freely from the pores of their leaves and bark. At that time, their juices are highly rarefied. The diameters of the tracheæ, or air-vessels, are enlarged, so as to press upon and straiten the vessels that carry the sap; in consequence of which, their juices, not being able to escape by the roots, are pressed upward where there is the least resistance, and perspire off the excrementitious parts by the leaves and branches, in the form of vapour. When the solar heat declines, the tracheæ are contracted, the sap vessels are enlarged, and the sap sinks down in the manner of the spirits of a thermometer. In consequence of this change, the capillary vessels of the leaves and top branches become empty. Being surrounded with the humid vapours of the evening, they fill themselves, from the known laws of attraction, and send down the new acquired juices to be mixed with those that are more elaborated. As soon as the sun has altered the temperature of the air, the tracheæ become again distended, and the sap-vessels are straitened. The same cause always produces the same effect; and this alternate ascent and descent through the same system of vessels, continues as long as the plant survives. The irregular motion of the stem and branches is another cause that contributes to the ascent of the sap. Whenever these parts are agitated by the air, they are made to assume a variety of angles, whereby the sap-vessels are suddenly straitened. The contained juices, consequently receive reiterated impulses, similar to what happens to the blood of animals from the contraction of the heart. These observations convey a general idea of the motion of the sap, which varies according to the temperature of the weather, which is seldom the same in any succeeding moment; and, therefore, the sap must sometimes move more quickly, and sometimes slow: it may rise and fall many times in the day, pushed forward by sudden heats, and falling by sudden cold. Thus the juices are blended, and the secretions forwarded.

An ingenious female naturalist, Mrs. *Agnes Ibbetson,* has published an interesting series of Essays on Vegetable Physiology in the 'Philosophical Magazine.' In a few particulars she assigns different functions to certain portions of plants, to those pointed out in these Papers; though in the main she agrees. In her comparison between animal and vegetable life, she proves, that the vegetable frame is a mere muscular creature, having life only, but no *sensation*; possessing alone the property of the muscles, *irritability*. The comparison proves also, that as the *only* part in the human body that possesses self-*motion,* independent of all other parts, is the muscle; so the only part in the plant that possesses the same *vis insita*, is the *spiral wire*, which therefore operates as the muscle of the vegetable. (See the Philosophical Magazine for August, 1815.)

No. XXIX.

THE PROCESS OF NATURE IN THE VEGETATION OF PLANTS.

Nor only through the lenient air this change,
Delicious, breathes; the penetrative sun,
His force deep darting to the dark retreat
Of vegetation, sets the streaming power
At large, to wander o'er the verdant earth,
In various hues. THOMSON.

Hos natura modos primum dedit: his genus omne
Sylvarum fruticumque viret. VIRGIL.

Thus Nature did ordain,
For trees, and shrubs, and all the sylvan reign.
DRYDEN.

THE theory of the ascent and descent of the ap in plants, with which I concluded my former aper, is beautifully adopted by Thomson, in a oble apostrophe to the God of Seasons:

Hail, Source of Being! Universal Soul
Of heaven and earth! Essential Presence hail!
To Thee I bend the knee; to Thee my thoughts,
Continual, climb; who, with a master-hand,
Hast the great whole into perfection touched.
By Thee the various vegetative tribes,
Wrapt in a filmy net, and clad with leaves,
Draw the live ether, and imbibe the dew:

By Thee disposed into congenial soils,
Stands each attractive plant, and sucks, and swells
The juicy tide, a twining mass of tubes:
At thy command the vernal sun awakes
The torpid sap, detruded to the root
By wintry winds; that now in fluent dance,
And lively fermentation, mounting, spreads
All this innumerous-coloured scene of things.

I shall now consider the very curious and mirable process of nature in the vegetation plants, which is described to this effect by excellent Malpighi and others: The seed of plant, after it has dropped from the pod or h may be considered as an impregnated egg, wi which the embryo plant is securely lodged. I few days after it has been committed to the ea may be observed the rudiments of the future pl every part of which appears to exist in miniat The nutricious juices of the soil insinuate th selves between the original particles of the pl and bring about an extension of its parts. Th called the growth of the vegetable body; with regard to this increase by addition and tension, there seems to be a great analogy betw the animal and vegetable kingdoms, on wh however, I shall not enlarge.

To illustrate the subject of vegetation, le take a view of what happens to a bean, aft has been committed to the earth. In a few d sooner or later, according to the temperatur the weather and the disposition of the soil, external coverings open at one end, and disc to the naked eye part of the placenta, or bod the grain. This substance consists of two lo or divisions, between which the seminal plar securely lodged. Soon after the opening of membranes, a sharp-pointed body appears, w is the root. By a kind of principle, which se *to bear* some appearance of instinct, it see passage downward, and fixes itself into the soil. At this period, the root is a smooth and polished body, and has, perhaps, but little power to absorb any thing from the earth, for the nutriment of the germ or sprout. The two lobes now begin to separate, and the germ, with its leaves, may be plainly discovered. As the germ increases in size, the two lobes are further separated, and the tender leaves, being closely joined, push themselves forward in the form of a wedge. These leaves take a contrary direction to the root. They seek a passage upward, which having obtained, they lay aside their wedge-like form, and spread themselves in a horizontal direction, as being the best adapted for receiving the rain and dew. The root, increasing every hour in size and vigour, pushes itself deeper into the earth, from which it now draws some nutritive particles. At the same time, the leaves of the germ, being of a succulent nature, assist the plant, by attracting from the atmosphere such particles as the tender vessels are fit to convey. These particles, however, are of a watery kind, and have not in their own nature a sufficiency of nutriment for the increasing plant. Vegetables, as well as animals, during their tender state, require a large share of balmy nourishment. As soon as an animal is brought into life, the milk of its mother is supplied in a liberal stream; while the tender germ seems to have only the crude and watery juices of the earth for its support. This, however, is not the case: for the vegetable lives upon a similar fluid, although differently supplied. For its use, the farinaceous lobes are melted down into a milky juice, which, as long as it lasts, is conveyed to the tender plant by innumerable small vessels, which are spread through the substance of the lobes. These vessels, uniting into one common trunk, enter the body of the germ, and perform the office of an umbilical chord. Without this supply of balmy liquor, the plant must inevitably have perished, its root being then too small to absorb a sufficiency of food, and its body too weak to assimilate it into nourishment.

Turnips, and all the tribe of cabbages in opposition to the leguminous and farinaceous plants, spread their seminal leaves[1] upon the surface: these leaves contain all the oil of the seed, which, when diluted by the moisture of the atmosphere, forms an emulsion of the most nourishing quality; and, on account of its sweetness, the seminal leaves are greedily devoured by the fly. A grain of wheat, as soon as the germ has made its appearance, shows the milky liquor to the naked eye; but the umbilical chord, with its ramifications, can be discovered only by the assistance of the nicest glasses. As the plant increases in size, the balmy juice diminishes, till, at last, it is quite exhausted. The umbilical chord then dries up, and the external covering of the grain appears connected with the root in the form of a shrivelled bag. In the process of vegetation, there is no mortality: from the moment that the seed is lodged in its parent earth, the vegetative principle begins its operations, and, in the whole successive gradation of them, illustrates the wisdom, the power, and the bounty of Providence. It is worthy of observation, moreover, that farinaceous vegetables and oviparous animals are nourished in their tender state nearly in the same manner. The embryo plant is supported by the farina melted down into a milky liquor, and conveyed into its body by means of an umbilical chord, at a time when the radicle was unable to supply a sufficiency of nutriment. An oviparous animal, from the time that it is brought into light, seems to receive all its nourishment from without; but this is in appearance only. The yolk of the egg, remaining entire during incubation, is received into the body of the animal, and, in a manner similar to the milky juice of the vegetable, is slowly conveyed into the vessels of the tender chick; and thus a sweet nourishment is prepared at a time, when neither the industry of the animal, nor the attention of its mother, could have procured a sufficient supply.

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[1] All seeds have two coverings, which answer to the *chorion* and *amnion* in anatomy, and two lobes, or divisions, which perform the office of the *placenta*. These lobes constitute the body of the seed; and, in the farinaceous kinds, they are the flour of the grain. Innumerable small vessels run through the substance of the lobes, which, uniting as they approach the seminal plant, form a small chord to be inserted into the body of the grain. Through this the nutriment supplied by the placenta or lobes is conveyed for the preservation and increase of the embryo plant. Here it may be observed, that the lobes of farinaceous grains are fixed in the earth; they are, therefore, improperly termed *seminal leaves*, being rather the *placenta* or *cotyledons* of the plant. On the contrary, vegetables that have an oily seed, as rape, hemp, and turnip, carry their lobes upward, and spread them upon the surface in the form of broad leaves. These, though they perform the office of a placenta, are properly seminal leaves.

That the whole plant is contained in the seed, is an opinion as old as Empedocles; and it is still the prevailing doctrine among the generality of naturalists. Experience, the microscope, and the modern philosophy, give great countenance to it: for it is certain, that by the use of good microscopes, we discover, in the seed, several of the parts of the future plant, only in miniature; particularly a little root called the *radicle*, and the stem called the *plumule*.

In the life of Malpighi, we have a debate between him and signor Triumphetti, provost of the physic garden at Rome, whether the whole plant be actually contained in the seed. The affirmative is maintained by Malpighi, with cogent arguments; among which this is one, that in a kidney bean, before sown, the eye, assisted by the microscope, easily discovers leaves, a bud, and even the knots or implantations of the leaves on the stem. The stem itself also is very conspicuous, and plainly consists of woody fibres, and a series of little utricles. And Triumphetti having objected, that by poverty, transplantation, &c. several plants degenerated into others, particularly wheat into tares, and tares again into wheat; in answer to this, which is one of the strongest objections against that opinion, Malpighi replies, that he is not fully satisfied as to the truth of the objection; for that both he himself, and his friends, having made the experiment, no metamorphosis of the wheat succeeded; but, granting the metamorphosis, it is the soil, or the air, or the culture, that is in fault. Now, from a morbid and monstrous condition of Nature, there is no inferring her genuine and permanent state.

On this subject of seeds, there is one circumstance, which is too curious and remarkable to be passed over; namely, that in all countries, whether agriculture be promoted or neglected by mankind, Nature assists to sow and plant, as well as to fertilize the earth. The seeds of lofty trees are many of them winged; and, when they are ripe, the autumnal winds blow them off, and scatter them at a great distance from their mother plants. Others are in pods or husks, and not capable of being carried by the motion of the air; but Providence has given them as foods to birds, who carry them to distant places, and, in feeding, scatter part of the seed in soils proper for them to take root in and spring up. Even the droughts of the autumn contribute to increase and propagate trees and plants; for by causing deep chinks in the earth, the seeds of trees, and larger plants, that require depth, are lodged at proper depths for their growth, and, at the same time, secured from such animals as feed upon them. Many of the seeds of annual plants are provided with a light down, by which they are enabled, with the help of the wind, to rise to great heights, and spread themselves very wide, to propagate their species in distant lands. The sun, by its annual visit to the northern and southern tropic, alternately gives action and rest to vegetation. The floods, which, in many countries, fall, at certain seasons, from the mountains, cover the plains, and enrich the soil by the sediment of their waters. The frosts of winter, also, by expanding the moisture contained in the earth, loosen and break the clods, so as to make them give way to the spreading roots of vegetables; and swine, moles, and such other animals, root up and loosen the earth, and fit it to receive the roots of plants.

> Then spring the living herbs, profusely wild,
> O'er all the deep-green earth, beyond the power
> Of botanist to number up their tribes:
> Whether he steals along the lonely dale,
> In silent search; or through the forest rank,
> With what the dull incurious weeds account,
> Burst his blind way; or climbs the mountain rock,
> Fired by the nodding verdure of its brow;
> With such a liberal hand has nature flung
> Their seeds abroad; blown them about in winds;
> Innumerous mixed them with the nursing mould,
> The moist'ning current, and prolific rain. THOMSON.

Birds are natural planters of several sorts of wood and trees: they disseminate the kernels upon the earth, which, like nurseries, bring them forth till they grow up to their natural strength and perfection. Crows have been observed, at the latter end of autumn, planting a grove of oaks: they first made little holes in the ground with their bills, going about till the hole was deep enough, and then they dropped in the acorn, and covered it with earth and moss. Some think, that Providence has given the crows this instinct, solely for the propagation of trees: but others are of opinion, that it was given them principally for their own preservation, by hiding provision in time of plenty, in order to supply them in a time of scarcity; for it is observed, in tame pies and daws kept about houses, that they will hide their meat when they have plenty, and fetch it from their hiding-places when they want it. Such an instinct, therefore, in birds, may answer a double purpose, both their own support in times of need, and the propagation of the trees they plant; for, whenever they hide a great number of nuts or grain in the earth, we cannot suppose they find them all again, but that as many will remain in the plat of ground they make use of, as can well grow by one another. I shall add to this observation concerning the natural dispersion of seeds, that Providence has been amazingly bountiful in the wonderful increase of seed in many vegetables; insomuch, that with proper culture, the face of the whole earth might be covered, in a very few years, *from the seed of a single plant.*

No. XXX.

ON VARIOUS PHENOMENA IN THE VEGETABLE KINGDOM.

Admiration, feeding at the eye,
And still unsated, dwells upon the theme.
COWPER.

THE vegetable kingdom, considered in various *points* of view, exhibits innumerable phenomena, which excite great variety of sentiment and inexhaustible conjecture—Among these, the curious botanist will not fail to observe the locomotive faculty which vegetables possess, the extreme sensibility of some, and that remarkable phenomenon in particular, which is called the *sleep of plants*.

That power of changing place, which is called the locomotive faculty, is not peculiar to animals. Examples of different kinds of motion are to be discovered in the vegetable kingdom. When the roots of the tree, for instance, meet with a stone, or any other obstruction to their motion, in order to avoid it, they change their former direction. They will turn, moreover, from barren to fertile earth, which indicates something analogous to a selection of food; and when confined to a house, they will uniformly bend toward the window, or aperture, through which the rays of light are introduced.

The Mimosa, or Sensitive Plant, possesses the faculty of motion in a very eminent degree. On the slightest touch its leaves suddenly contract, and the branch bends towards the earth. The ingenious Darwin, in his 'Botanic Garden,' thus describes this delicate plant:

Weak with nice sense, the chaste Mimosa stands,
From each rude touch withdraws her timid hands;
Oft as light clouds o'erpass the summer-glade,
Alarmed she trembles at the moving shade;
And feels alive through all her tender form,
The whispered murmurs of the gathering storm;
Shuts her sweet eyelids to approaching night,
And hails with freshened charms the rising light.
Veiled, with gay decency and modest pride;
Slow to the mosque she moves, an eastern bride;
There her soft vows unceasing love record,
Queen of the bright seraglio of her lord,
So sinks or rises, with the changeful hour,
The liquid silver in its glassy tower;
So turns the needle to the pole it loves,
With *fine librations* quivering as it moves.

But the Hedysarum Gyrans, or Moving Plant, from the East Indies, where it is called Chundali Borrum, by the natives, exhibits the most astonishing example of vegetable motion. Its leaves are incessantly in spontaneous movement; some rising and others falling; and others whirling circularly by twisting their stems. Dr. Darwin, who places this plant, according to the Linnean or sexual system of Botany, in the class *Diadelphia, two brotherhoods, ten males,* thus describes the Hedysarum, in his beautifully fanciful account of the Loves of the Plants:

> Fair Chunda smiles amid the burning waste,
> Her brow unturbaned, and her zone unbraced;
> *Ten* brother-youths with slight umbrellas shade,
> Or fan with busy hands the panting maid;
> Loose wave her locks disclosing as they break,
> The rising bosom and averted cheek;
> Clasped round her ivory neck with studs of gold
> Flows her thin vest in many a gauzy fold;
> O'er her light limbs the dim transparence plays,
> And the fair form, it seems to hide, displays.

The motions of the Hedysarum cease during the night, and when the weather is cold and cloudy. Our wonder is excited by the rapidity and constancy of the movements peculiar to this plant. The frequency, however, of similar motions in other plants, may render it probable that the leaves of all vegetables move, or are agitated by the rays of the sun, although many of these movements are too slow for our perception.

The American plant called Dionæa Muscipula, or Venus's Flytrap, affords another instance of rapid vegetable motion. Its leaves are jointed, and furnished with two rows of strong prickles. Their surfaces are covered with a number of minute glands, which secrete a sweet liquor, and allure the approach of flies. When these parts are touched by the legs of a fly, the two lobes of the leaf intantly rise up, the rows of prickles lock them-lves fast together, and squeeze the unwary animal death. If a straw or pin be introduced between e lobes, the same motions are excited. Dr. arwin says, that the sweet viscous liquor just entioned, is a curious contrivance of Nature, to revent various insects from plundering the honey, r devouring the seed; and he thus poetically de-ribes the plant and this its remarkable pecu-arity:

> The fell Silene and her sisters fair,
> Skilled in destruction, spread the viscous snare,
> The harlot-band *ten* lofty bravoes screen,
> And frowning guard the magic nets unseen.
> Haste, glittering nations, tenants of the air,
> Oh, steer from hence your viewless course afar!
> If with soft words, sweet blushes, nods, and smiles,
> The *three* dread syrens [1] lure you to their toils,
> Limed by their art in vain you point your stings,
> In vain the effort of your whirring wings!
> Go, seek your gilded mates and infant hives,
> Nor taste the honey purchased with your lives.

When a seed is sown in a reversed position, the oung root turns downward to enter the earth, and he stem bends upward to ascend into the air. Con-ine a young stem to an inclined position, and its xtremity will soon assume its former perpendicular irection. Twist a branch of any tree in such a anner that the inferior surfaces of the leaves are urned toward the sky, and, in a short time, all hese leaves will resume their original position. hese motions are performed sooner or later, in roportion to the degree of heat, and the flexibility f the leaves. Many leaves, as those of the mallow, ollow the course of the sun. In the morning, their uperior surfaces are presented to the east; at oon, they regard the south; and, when the sun sets, they are directed to the west. During the night, or in rainy weather, these leaves are horizontal; and their inferior surfaces are turned toward the earth. The helianthus, or sunflower, also, follows the course of the sun:

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[1] Three females and ten males inhabit each flower.

> Great Helianthus guides o'er twilight plains
> In great solemnity his dervise trains;
> Marshalled in *fives* [1] each gaudy band proceeds,
> Each gaudy band a *plumed* [2] lady leads;
> With zealous steps he climbs the upland lawn,
> And bows in homage to the rising dawn;
> Imbibes with eagle-eye the golden ray,
> And watches, as it moves, the orb of day.

What has been denominated the *sleep of plants*, affords an instance of another species of vegetable motion. The leaves of many plants fold up during the night; but, at the approach of the sun, they expand with new vigour. The common appearances of most vegetables are so changed in the night, that it is difficult to recognise the different kinds, even by the assistance of light.

The modes of folding in the leaves, or of sleeping, are extremely various. But it is worthy of remark, that they all dispose themselves so as to give the best protection to the young stems, flowers, buds, or fruit. The leaves of the tamarind-tree contract round the tender fruit, and protect it from the nocturnal cold. The Cassia or Senna, the Glycine, and many of the papilionaceous plants, contract their leaves in a similar manner. The leaves of the Chickweed, of the Asclepias, Atriplex, &c. are disposed in opposite pairs: during the night, they rise perpendicularly, and join so close at the top, that they conceal the flowers. The leaves of the Sida or Althæa Theophrasti, of the Ayenia, and Œnothera, are placed alternately: though horizontal, or even depending, during the day, at the approach of night they rise, embrace the stem, and protect the tender flowers. The leaves of the Solanum, or Night shade, are horizontal during the day; but, in the night, they rise and cover the flowers. The Egyptian Vetch erects its leaves during the night, in such a manner, that each pair seems to be one leaf only. The leaves of the White Lupine, in the state of sleep, hang down, and protect the young buds from being injured by the nocturnal air.

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[1] The numerous florets, which constitute the disk of this flower, contain in each five males surrounding one female; and the five stamens have their anthers connected at top, whence the name of the class 'confederate males.'

[2] The seeds of many plants of this class are furnished with a *plume*, by which admirable mechanism they are disseminated by the winds far from their parent stem, and look like a shuttlecock, as they fly. Other seeds are disseminated by animals: of these some attach themselves to the hair or feathers by a gluten, as misleto; others by hooks, as cleavers, burdock, houndstongue; and others are swallowed for the sake of the fruit, and voided uninjured, as the hawthorn, juniper, and some grasses: other seeds again are dispersed by means of an elastic seed-vessel, as oats, geranium, and impatiens: and the seeds of aquatic plants, and of those that grow on the banks of rivers, are carried many miles by the currents into which they fall.

These and similar motions are not peculiar to the *leaves* of plants. The *flowers* have also the power of moving. During the night, many of them are inclosed in their calixes. Some flowers, as those of the German Spurge, Geranium Striatum, and common Whitlow-grass, when asleep, hang their mouths toward the earth, to prevent the noxious effects of rain or dew.

Linné has enumerated forty-six flowers, which possess this kind of sensibility: he divides them into three classes. (1) *Meteoric flowers*, which less accurately observe the hour of folding, but are expanded sooner or later according to the cloudiness, moisture, or pressure of the atmosphere. (2) *Tropical* *flowers*, that open in the morning and close l fore evening every day; but the hour of their (panding becomes earlier or later as the length the day increases or decreases. (3) *Equinoct flowers*, which open at a certain and exact hour the day, and for the most part close at another (terminate hour.

In every copse, and sheltered dell,
Unveiled to the observant eye,
Are faithful monitors, who tell
How pass the hours and seasons by.

The green robed children of the spring
Will mark the periods as they pass,
Mingled with leaves time's feathered wing,
And bind with flowers his silent glass.

Mark where transparent waters glide,
Soft flowing o'er their tranquil bed;
There, cradled on the dimpling tide,
Nymphæa rests her lovely head.

But conscious of the earliest beam,
She rises from her humid nest,
And sees reflected in the stream
The virgin whiteness of her breast.

Till the bright day star to the west
Declines, in Ocean's surge to lave,
Then, folded in her modest vest,
She slumbers on the rocking wave.

See *Hieracium's* various tribe,
Of plumy seed and radiate flowers,
The course of Time their blooms describe,
And wake or sleep appointed hours.

Broad o'er its imbricated cup
The *Goatsbeard* spreads its golden rays,
But shuts its cautious petals up,
Retreating from the noon-tide blaze:

Pale as a pensive cloistered nun
The *Bethlem star* her face unveils,
When o'er the mountain peer the Sun,
But shades it from the vesper gales.

Among the loose and arid sands
  The humble *Arenaria* creeps ;
Slowly the *purple star* expands,
  But soon within its calyx sleeps.

And those small bells so lightly rayed
  With young Aurora's rosy hue,
Are to the noon-tide Sun displayed,
  But shut their plaits against the dew.

On upland slopes the shepherds mark
  The hour, when, as the dial true,
Cichorium to the towering Lark
  Lifts her soft eyes serenely blue.

And thou, 'Wee crimson tipped flower,'
  Gatherest thy fringed mantle round
Thy bosom, at the closing hour,
  When nightdrops bathe the turfy ground.

Unlike *Silene*, who declines
  The garish noontide's blazing light ;
But when the evening crescent shines
  Gives all her sweetness to the night.

Thus in each flower and simple bell,
  That in our path untrodden lie,
Are sweet remembrancers who tell
  How fast their winged moments fly.

CHARLOTTE SMITH.

The cause of those movements which constitute the sleep of plants, has been ascribed to the presence or absence of the sun's rays. In some of the examples I have given, the motions produced are evidently excited by heat. But plants kept in a hothouse, where an equal degree of heat is preserved both day and night, fail not to contract their leaves, or to sleep, in the same manner as when they are exposed to the open air. This fact evinces, that the sleep of plants is rather owing to a peculiar law, than to a quicker or slower motion of their juices.

The degrees of sensation in created objects decrease imperceptibly from man to the sea gall-insects, and what are called the most imperfect animal. Every vegetable, as well as the sensitive plant, shrinks when wounded. But, in most of them, the motion is too slow for our perception. When trees grow near a ditch, the roots which proceed in a direction that would necessarily bring them into the open air, instead of continuing this noxious progress, sink below the level of the ditch, then shoot across, and regain the soil on the opposite side. When a root is uncovered, without exposing it to much heat, and a wet sponge is placed near it, but in a different direction from that in which the root is proceeding, in a short time the root turns toward the sponge. In this manner the direction of roots may be varied at pleasure. All plants make the strongest efforts, by inclining, turning, and even twisting their stems and branches, to escape from darkness and shade, and to procure the influences of the sun. Place a wet sponge under the leaves of a tree, they soon bend downward, and endeavour to apply their inferior surfaces to the spunge. If a vessel of water be placed within six inches of a growing cucumber, in twenty-four hours the cucumber alters the direction of its branches, bends either to the right or left, and never stops till it comes into contact with the water. When a pole is placed at a considerable distance from an unsupported vine, the branches of which are proceeding in a contrary direction from that of the pole, in a short time, it alters its course, and stops not till it clings around the pole. But facts, of this kind, however they may excite our wonder, are far from *proving* that vegetables live, or that they are endowed with sensation, which implies a distinct perception of pleasure and pain: the whole may result from *irritability* which as before remarked, is a muscular property, common to animals and vegetables.

Plants, undoubtedly, make a very near approach to animals, and this similarity, as well as the difficulty of fixing the precise boundaries by which the two great kingdoms of nature are limited, are direct consequences of the organization of vegetables. It is owing to their organic structure alone, that plants and animals are capable of affording reciprocal nourishment to each other. This organic structure, though greatly diversified in the different species of animals and vegetables, evinces that Nature, in the formation of both, has acted upon the same general plan. "May we not presume, therefore, (says an ingenious naturalist[1]) that as plants as well as animals are composed of a regular system of organs, that the vegetable part of the creation is not entirely deprived of every quality which we are apt to think peculiar to animated beings? I mean not to insinuate, that plants can perceive pleasure or pain. But, as many of their motions, and affections cannot be explained upon any principle of mechanism, I am inclined to think, that they originate from the power of irritability, which, though it implies not the perception of pleasure and pain, is the principle that regulates all the vital or involuntary motions of animals. To ascertain this point, would require a set of very nice experiments. I shall mention one, which might be performed with tolerable ease. It was formerly remarked, that plants kept in a hothouse, where the degree of heat is uniform, never fail to sleep during the night. This is direct evidence, that heat alone is not the cause of their vigilance. But they are deprived of light. Let, therefore, a strong artificial light, without increasing the heat, be thrown upon them. If, notwithstanding this light, the plants are not roused, but continue to sleep as usual, then it may be presumed that their organs, like those of animals, are not only irritable, but require the reparation of some invigorating influence which they have lost while awake, by the agitations of the air and the sun's rays, by the act of growing, or by some other latent cause.

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[1] Dr. Smellie, *in his* Philosophy of Natural History.

Of some plants it is remarkable, that they flower only in the night, and of others, that it is then only they emit their fragrance. The Cactus Grandiflorus, or Night-blowing Cereus[1], which is a native of Jamaica and Vera Cruz, expands a very exquisitely beautiful corol, and emits a very fragrant odour, for a few hours in the night, and then closes to open no more. The flower is nearly a foot in diameter, the inside of the calyx of a splendid yellow, and the numerous petals of a pure white. It begins to open about seven or eight in the evening, and closes before sunrise.—Of its appearance in its native climes, our botanical poet thus sings, in a beautiful apostrophe:

> Nymph! not for thee the radiant day returns,
> Nymph! not for thee the golden solstice burns,
> Refulgent Cerea! At the dusky hour
> She seeks, with pensive step the mountain bower,
> Bright as the blush of rising morn, and warms
> The dull cold eye of Midnight with her charms,
> Then to the skies she lifts her pencilled brows,
> Opes her fair lips, and breathes her virgin vows;
> Eyes the white zenith; counts the suns, that roll
> Their distant fires, and blaze around the pole;
> Or marks where Jove directs his glittering car
> O'er heaven's blue vault.—Herself a brighter star.
> There, as soft Zephyrs sweep with pausing airs
> Thy snowy neck, and part thy shadowy hairs,
> Sweet Maid of Night! to Cynthia's sober beams
> Glows thy warm cheek, thy polished bosom gleams.
> *In crowds* around thee gaze th' admiring swains,
> And guard in silence the enchanted plains;

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[1] Twenty males, one female.

Drop the still tear, or breathe th' impassioned sigh,
And drink inebriate rapture from thine eye.

The Nyctantheus, or Arabian Jasmine, is another flower, which expands a beautiful corol, and emits a very delicate perfume during the night, and not in the day, in its native country, whence its name. Botanical philosophers have not yet explained this wonderful property; perhaps the plant sleeps during the day as some animals do, and its odoriferous glands emit their fragrance only during the expansion of the petals; that is, during its waking hours. The Geranium tribe has the same property of emitting its fragrance during the night only. The flowers of the Cucurbita Lagenaria are said to close when the sun shines upon them. In our climate, many flowers, as Tragopogon and Hibiscus, close their flowers before the hottest part of the day comes on; and the flowers of some species of Cuculalus, and Silene, Viscous Campion, are closed all day; but when the sun leaves them, they expand, and emit a very agreeable scent. On this account, such flowers are called *noctiflori*.

I shall close this paper by observing, that what is in common language called a bulbous root, is by Linné called the Hybernacle, or Winter-lodge of the young plant; as these bulbs in every respect resemble buds, except in their being produced under ground, and include the leaves and flower in minature, which are to be expanded in the ensuing spring. By cautiously cutting in the early spring through the concentric coats of a tulip-root, longitudinally from the top to the base, and taking them off successively, the whole flower of the next summer's tulip is beautifully seen by the naked eye, with its petals, pistil, and stamens: the flowers exist in other bulbs, in the same manner, as in Hyacinths, but the individual flowers of these being less, they are not so easily dissected, or so conspicuous to the naked eye. In the seed of the Nymphæa Nelumbo, the leaves of the plant are seen so distinctly, that Mr. Ferber, found out by them to what plant the seed belonged. He says, that Mariotte first observed the future flower and foliage in the bulb of a tulip; and he adds, that it is pleasant to see in the buds of the Hepatica and Pedicularis Hirsuta, yet lying in the earth, and in the gems of Daphne Mezereon, and at the base of Osmunda Lunaria, a perfect plant of the future year complete in all its parts.

The retiring of the Tulip to its Hybernacle, or Winter-lodge, is thus beautifully noticed by the elegant poet I have already quoted with so much pleasure:

When o'er the cultured lawns and dreary wastes
Retiring Autumn flings her howling blasts,
Bends in tumultuous waves the struggling woods,
And showers their leafy honours on the floods,
In withering heaps collects the flowery spoil;
And each chill insect sinks beneath the soil:
Quick flies fair Tulipa the loud alarms,
And folds her infant closer in her arms;
In some lone cave, secure pavilion, lies,
And waits the courtship of serener skies.—
So, six cold moons, the dormouse charmed to rest,
Indulgent sleep! beneath thy elder breast,
In fields of fancy climbs the kernelled groves,
Or shares the golden harvest with his loves.—

DARWIN.

No. XXXI.

REFLECTIONS ON THE DIVINE WISDOM AND POWER IN THE MINUTER PARTS OF CREATION.

O Nature, whose Elysian scenes disclose
His bright perfections at whose word they rose,
Next to that Pow'r who formed thee and sustains,
Be thou the great inspirer of my strains.
Still as I touch the lyre, do thou expand
Thy genuine charms, and guide an artless hand;
That I may catch a fire but rarely known,
Give useful light though I should miss renown.
And poring on thy page, whose ev'ry line
Bears proof of an intelligence divine,
May feel a heart enriched by what it pays,
That builds its glory on its Maker's praise.
Woe to the man whose wit disclaims its use,
Glitt'ring in vain, or only to seduce,
Who studies Nature with a wanton eye,
Admires the work, but slips the lesson by.

COWPER.

O Nature, thy minutest works amaze,
Pose the close search, and lose our thoughts in praise!

BROWNE.

THE animated language of the poet may be adopted, with the greatest propriety, by the philosopher, who studies the works of Nature not merely for the gratification of curiosity, or the amusement of a vacant moment, but for the nobler purpose of diffusing instruction, and of teaching his fellow-creatures to adore, as becomes them, the Great Creator, Governor and Preserver of All. Not he alone is to be esteemed a benefactor to mankind, who makes useful discovery, but he also who can point out nd recommend an innocent and instructive pleasure. *Of this kind* are the pleasures which arise from the observation of Nature, and that not only in her greatest and most stupendous works, but in those which are so wonderfully minute as to be imperceptible by the naked eye. For it is not alone in the radiant orbs above, in their astonishing magnitude, and regular order, that the Deity is conspicuous, but in the beautiful structure and colours of a flower or a leaf, in the parts and conformation of the minutest insect, and of those infinite varieties of animalcules, which are the object of microscopic vision.

In the 148th Psalm, not only the angelic choirs, and the whole human race, but even the celestial bodies, and all the inanimate world below, are exhorted, by a noble prosopopœia to praise their great Creator: '*Praise ye the Lord in the heavens: praise him in the heights. Praise ye him all his angels; praise ye him all his hosts. Praise ye him sun and moon; praise him all ye stars of light. Praise him ye heaven of heavens, and ye waters that are above the heavens. Let them praise the name of the Lord; for he commanded, and they were created.*'—Not that the celestial bodies, senseless and inanimate as they are, can utter the stupendous praise of their Creator, but that they incessantly exhibit the most magnificent display of his attributes and perfections. '*The heavens declare the glory of God, and the firmament showeth his handy work.*'—When these therefore, are exhorted to praise God, nothing more can be understood, than that Man, whom he made to look erect, and taught alone to contemplate the skies[1], should incessantly ok him in those glorious manifestation of omnitent energy and influence; should consider him those unnumbered effects of infinite wisdom, ir prodigious dimensions, their regular motions d periods, their admirable disposition and order, d their eminent uses in illuminating and enliven- the planets and other bodies around them, as ll as their respective inhabitants, by the vivifying d cheering influence of their light and heat; and, fine, should ascribe to God the glory of his power making such great and illustrious bodies, as well as the glory of his wisdom and goodness, in placing and disposing them in such a manner, nd ordering their motions with such invariable regularity, that they never clash nor interfere with ach other.

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[1] Os homini sublime dedit: coelumque tueri
Jussit, et erectos ad sidera tollere vultus. OVID.

He with a lofty look did man endue,
And bade him heav'n's transcendent beauties view.
SANDYS.

Nor are the contemplations of man confined to the resplendent orbs on high. By the same figure of speech he is invited to the study of universal Nature: '*Praise ye the Lord from the earth, ye dragons and all deeps: fire and hail, snow and vapour, stormy wind fulfilling his word; mountains and all hills, fruitful trees and all cedars; beasts and all cattle, creeping things, and flying fowl.*'—We do not resolve this exhortation into the mere beauty and boldness of poetical decoration. Fire, hail, snow, the elements and meteors; the trees and other plants; the beasts, birds, insects, and other tribes of animated nature, with whatever degrees of sense and perception the latter are endued, are in themselves incapable of praising the Divine Being. When they, therefore, are exhorted to praise God, we are to understand that Man is commanded to investigate their various properties and powers; to consider their curious structure and conformation, with the admirable ends for which they were created, and to ascribe that glory, in course, to the beneficent Creator, which such wonderful displays of goodness, wisdom, and power, must naturally demand: '*Kings of the earth, and all people; princes and all judges of the earth; both young men and maidens, old men and children; let them praise the name of the Lord: for his name alone is excellent, his glory is above the earth and heaven.*'

It must not here be unnoticed, that the pious author of this Psalm calls upon insects also, those minuter creatures, to join in the universal hymn: intimating thus, that what may seem in our eyes to be the meanest and most contemptible part of the creation, can afford subjects of admiration and devotion to the pious and contemplative inquirer: for there can be nothing which the Deity has condescended to create, which is, in any respect, unworthy the attention of man. The works of Nature are no less wonderful in the smallest than in the largest bodies. We may discover in the former, as well as in the latter, a kind of *infinite*, that at once astonishes and confounds. How wonderful to find in a ringworm, as in an elephant or a whale, members perfectly organized: to discover a head, a body, legs, and feet, like those of the largest animals! In each part of these living atoms are muscles, nerves, veins, arteries, and blood. This blood is furnished with spirits, ramified parts, and humours. The humours again are made up of various particles; so that thought is lost in tracing the progression of a composition so infinitely minute. In a word, the more accurate our inquiries into this subject, the greater reason shall we have for assenting to the propriety of the observation, that the Supreme Being is, indeed, '*maximus in minimis*—the greatest in the least.'

The microscope displays to us, in each object, as it were, a thousand others which escaped our knowledge. Yet, in every object discovered by this instrument, others still remain unseen, which the microscope itself can never produce. What wonders should we see if we could continually improve those glasses, which are invented for the assistance of our rude and feeble sight! But we may supply, by our imagination the defect of our eyes, and make it serve as a microscope to represent in each atom a thousand new and invisible worlds. It cannot, however, incessantly figure to us new discoveries in bodies so infinitely small. The task would be too painful. It is necessary that the imagination should stop its inquiries, and leave, in the minutest organ, a thousand wonders undiscovered still. Let it suffice, that a single glance will enable us to discover in a small animal, even in an ant, more than we can find in the sun; a wisdom and power delighting to show itself in forming and finishing the meanest of its works.

Myriads of creatures (each too nicely small
Bare sense to reach) for thy inspection call.
In animalcules, germs, seeds, and flowers
Live, in their perfect shapes, the little pow'rs.
Vast trees lie pictured in their slend'rest grains:
Armies one wat'ry globule contains.
The artificial convex[1] will reveal
The forms diminutive that each conceal;
Some, so minute, that, to their fine extreme,
The mite a vast leviathan will seem:
That yet of organs, functions, sense partake,
Equal with animals of largest make,
In curious limbs and clothing they surpass
By far the comeliest of the bulky mass.
A world of beauties! that thro' all their frame,
Creation's grandest miracles proclaim.

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Search the least path Creative Pow'r has trod
How plain the footsteps of th' apparent God!

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[1] Some of these amazing instruments magnify the cube, or solid square of an object, above 500 millions of times. Those viewed by the solar microscope may be extended to almost any dimensions.

His art could organs, strength, and sense implant
In the small agile fly and reptile ant.
In the mean mite, so much minuter still,
Thy finger's pressing point may millions kill.
Marked by the magnifying crystal's aid,
In ev'ry place what proofs will stand displayed!
Lo! from the stagnant pool one drop obtain;
Of insects this includes a sumless train:
Buoyed in the little pool they frisk and play,
Pleased with their short existence of a day.
That blue with which the glossy plum is graced,
That gives such poignant pleasure to its taste,
Or azures o'er the damson's velvet rind,
A group of smallest animals we find.
The little gnat, in beauties, may compare
With all his rival brothers of the air;
Transparent feathers, purple, green, and gold,
His wings, small feet, and gay-fringed tail infold;
Four sharpened spears his head with weapons arm,
And his pearled eyes[1] with liveliest graces charm.

* * * * *

Thy microscopic glass admiring bring,
And view the humble hornet's sharpened sting;
Then on the slend'rest needle turn thy eye,
And the vast difference in their points descry:
This viewed, more polished seems, acuter far;
That, rough as from the forge some blunted bar.
God's smallest work all human skill degrades,
Foils the lost man, and sinks his worth in shades.

M. BROWNE.

By the microscope, indeed, we are enabled to perceive, that the minutest works of Nature are adorned with the most consummate elegance and beauty. There are such inimitable gildings and embroideries in the smallest seeds of plants, but especially in the parts of animals, in the head and eye of a small fly; such accurate symmetry, more-ever, in the frame of the most minute creature, such as a flea, a louse, or a mite; as it would be impossible for any mortal to conceive, without a previous inspection of them. But I shall not, at present, enter any further into the wonderful variety of particulars which might be collected on this subject. I shall confine myself to such reflections as the last lines of the above poetical extract must naturally suggest; namely, the very striking contrast which the microscope discovers between the works of Nature and the efforts of Art. Nature, it is observed, is not less remarkable for the accuracy and beauty of all her works than for variety and profusion. Defects, on the contrary, are always discovered in the works of Art, when examined with a microscope; while the close inspection of a leaf of a flower is like removing a veil from the face of beauty. The finest needle ever polished, and pointed by the most ingenious artist, appears, when it is viewed by the solar microscope, quite obtuse; while the sting of a bee, however magnified, still retains all its orinal acuteness of termination. The most accurate engravings or embossments seem such rude and deformed work, when thus magnified, as if they had been wrought by a mattock or a trowel; and the threads of the finest cambric appear like packthread, and seem rather the workmanship of a basket-maker, than the beautiful production of the loom. On the contrary, the serrated borders of the petal of a flower, and the fringe on the wing of a fly, display an accuracy of delineation, which no pencil can rival. Such an infinite difference is there between the exquisite skill of Nature and the comparative rudeness and imperfection of Art[1].

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[1] These are composed of several hundred little hemispheres, or, in reality, so many distinct eyes; which have such a power of magnifying, and are of such a wonderful structure, in numbers of the minutest insects, that they are capable of discovering objects, many thousand times *less* than themselves.

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[1] It is a great mortification to the vanity of man, that his utmost art and industry can never equal the meanest

I think, therefore, that I cannot better
clude this paper, than by observing, what a
consistency it is in the character of a rational b
to be transported with the workmanship of a
mortal, and to feel no rapture in surveying th
imitable performances, in which the hand of
is so visible. The subject, moreover, may su
to us a becoming caution, not to treat with
temptuous superiority, and much less with
tonness and cruelty, the meanest of those
tures, to the formation and decoration of
God himself has been so attentive: for if w
alt our views to the celestial orbs above, and
ceive the possible existence, in other world
beings infinitely superior to us in dignity and
cellence, yet still infinitely remote from the
in perfection; how comparatively minute and
temptible may we appear to them! But, n
wander in the fields of imagination, with wha
phasis and propriety has the Psalmist taugh
to exclaim, '*When I consider the heavens, the*
of thy fingers, the moon and the stars which
hast ordained, what is man that thou art mind
him, and the son of man that thou visitest him

The examination of flowers by the micro
opens a new field of wonder to the inquirin
turalist. As a pleasing illustration of the pr
ing paper, we subjoin Sir John Hill's intere
account of what appeared on examining a c
tion first published in the Inspector, No. 109
is written with peculiar elegance. 'The prin

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of Nature's productions, either for beauty or value,
is only the under workman, and is employed to give
strokes of embellishment to those species, which
from the hand of the master. Some of the drapery n
of his drawing; but he is not allowed to touch the
cipal figure. Art may make a suit of clothes: but N
must produce a man. HUME.

lower in this *bouquet*, was a *carnation:* the fragrance of this led me to enjoy it frequently and near: the sense of smelling was not the only one affected on these occasions; while that was satiated with the powerful sweet, the ear was constantly attacked by an extremely soft but agreeable murmuring sound. Curiosity is a first principle in my nature on all occasions of this kind. It was easy to know that some animal, within the covert, must be the musician, and that the little noise must come from some little body suited to produce it. I am furnished with apparatusses of a thousand kinds for these occasions. I instantly distended the lower part of the flower, and, placing it in a full light, could discover troops of little insects frisking and capering with wild jollity among the narrow pedestals that supported its leaves, and the little threads that occupied its centre. What a fragrant world for their habitation! what a perfect security from all annoyance in the deep husk that surrounded their scene of action!

'I was not cruel enough to pull out any one of them for examination; but adapting a microscope to take in, at one view, the whole base of the flower, I gave myself an opportunity of contemplating what they were about, and this for many days together, without giving them the least disturbance. Thus could I discover their economy, their passions, and their enjoyments. With what adoration to the Hand that gave being to these minute existences must a heart, capable of a due warmth in His praise, see the happiness he has bestowed on them! But, alas! all magnitude is but comparative; an accident of matter, not one f its properties; and, in reality, a very nothing n no degree affecting the subjects themselves, hough of such seeming consequence to us.

'The microscope, on this occasion, had g what nature seemed to have denied to the obj of contemplation. The base of the flower tended itself under its influence to a vast pl the slender stems of the leaves became tr of so many stately cedars; the threads in middle seemed columns of massy structure, porting, at the top, their several ornaments; the narrow spaces between were enlarged walks, parterres, and terraces.

'On the polished bottom of these, brig than Parian marble, walked in pairs, alone, larger companies, the winged inhabitants: from little dusky flies (for such only the nake would have shown them) were raised to glo glittering animals, stained with living purple, with a glossy gold that would have mad the labours of the loom contemptible in the parison.

'I could, at leisure, as they walked togethe mire their elegant limbs, their velvet shoul and their silken wings; their backs vyeing the empyræan in its blue; and their eyes, formed of a thousand others, out-glittering little planes on a brilliant; above description, too great almost for admiration. I could serve them here singling out their favourit males, courting them with the music of buzzing wings, with little songs formed for little organs, leading them from walk to among the perfumed shades, and pointing to their taste the drop of liquid nectar just ing from some vein within the living trunk: were the perfumed groves, the more than shades of the poet's fancy, realised; here happy lovers spent their days in joyful dalli or, in the triumph of their little hearts, ski ter one another from stem to stem among the inted trees; or winged their short flight to the lse shadow of some broader leaf, to revel undisrbed in the heights of all felicity[a].'

No. XXXII.

FURTHER REFLECTIONS ON THE MINUTE WONDERS OF CREATION.

Nature's *great* works no distance can obscure,
No *smallness* her near objects can secure:
We've learned the curious sight to press
Into the privatest recess
Of her imperceptible littleness!
We've learned to read her smallest hand,
And well begun her deepest sense to understand.
COWLEY.

In an insect or a flower,
Such microscopic proofs of skill and power,
As hid from ages past, God now displays,
To combat atheists with in modern days. COWPER.

IN my preceding Paper, I considered, in geeral, the great superiority of the works of Nature ver those of Art, as particularly discernible in e objects of microscopic vision. This is a subct of contemplation, of which the ancients had o conception, and of which, consequently, they n afford us no poetical illustrations. It was rerved for modern philosophy, moreover, to invent e means of bringing creatures, imperceptible to e naked eye, under our cognizance and inspection; and to furnish the contemplative poets of our age with new subjects of adoration.

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[a] The whole of this Paper will be found in Dr. Drake's leaner, vol. ii. p. 268.

Gradual—What numerous kinds descend,
Evading ev'n the microscopic eye!
Full Nature swarms with life; one wondrous mass
Of animals, or atoms organized,
Waiting the vital breath, when parent Heaven
Shall bid his Spirit blow. The hoary fen,
In putrid streams, emits the living cloud
Of pestilence. Thro' subterranean cells,
Where scorching sun-beams scarce can find a way,
Earth animated heaves. The flowery leaf
Wants not its soft inhabitants. Secure,
Within its winding citadel, the stone
Holds multitudes. But chief the forest-boughs,
That dance unnumbered to the playful breeze,
The downy orchard, and the melting pulp
Of mellow fruit, the nameless nations feed
Of evanescent insects. Where the pool
Stands mantled o'er with green, invisible,
Amid the floating verdure millions stray.
Each liquid too, whether it pierces, soothes,
Inflames, refreshes, or exalts the taste,
With various forms abounds. Nor is the stream
Of purest crystal, nor the lucid air,
Though one transparent vacancy it seem,
Void of their unseen people. These concealed
By the kind art of forming Heaven, escape
The grosser eye of man: for, if the worlds
In worlds inclosed should on his senses burst,
From cates ambrosial, and the nectared bowl,
He would abhorrent turn; and in dead night,
When silence sleeps o'er all, be stunned with noise.

THOMSON.

The word *animalcule*, the general name of thes creatures, is a diminutive of *animal;* expressin such a minute creature, as is either scarcely, (not at all, to be discerned by the naked eye. Suc are those numerous insects, which crowd the wat in the summer months; changing it sometimes (a deep or pale red colour, sometimes of a yellov &c. and which are found imbedded in the ice i the winter[1]. These often seem to be of the shrimp kind, and the most common one is called by Swammerdam, *pulex aquaticus arborescens.* Their concourse at this time, as Derham observes, is for the purpose of propagating their species; and he adds, that they afford a comfortable nourishment to many water animals. The green scum, on the top of stagnant waters, is often nothing else but prodigious numbers of another smaller order of animalcules, which, in all probability, serves for food to the *pulices aquatici.*

The microscope discovers legions of animalcules in most liquors, as water, wine, vinegar, beer, dew, &c. In the Philosophical Transactions we have observations of the animalcules in rain-water, in several chalybeate waters, and in infusions of pepper, bay-berries, oats, barley, and wheat.

Those who have made the most minute and accurate researches into the natures of the several objects subjected to their senses, have found that the substances upon which they employed their curiosity, were often quite different from what they seemed to be at first view. Thus, for instance, the whole earth has been found replenished with an inexhaustible store of what we should least of all suspect—an infinite number of animalcules floating in the air we breathe, sporting in the fluids we drink, or adhering to the several objects we see and handle.

Far less than mites, on mites they prey;
  Minutest things may swarms contain;
When o'er your ivory teeth they stray,
  Then throb your little nerves with pain.

Fluids, in drops, minutely swell;
  These subtile beings each contains;
In the small sanguine globes they dwell,
  Roll from the heart, and trace the veins.

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[1] See No. I.

Through every tender tube they rove,
In finer spirits strike the brain;
Wind quick through every fibrous grove,
And seek, through pores, the heart again.
SAVAGE.

The conjectures and hypotheses relating to the production, generation, structure, and uses of these animalcules, have been as various as were ever contrived by caprice, or embraced by credulity. But not to bewilder my readers in these labyrinths, I will confine my observations to actual discoveries. By the assistance of the microscope, we not only perceive that such animalcules exist, but are also enabled in some degree, to determine their shapes, and the various peculiarities of their motion. In a word, the contemplation of animalcules has made the ideas of infinitely small bodies familiar to us. A mite was anciently thought the limit of littleness;

The polished glass, whose small convex,
Enlarges to ten millions of degrees
The mite, invisible else, of Nature's hand
Least animal; and shows what laws of life
The cheese-inhabitants observe, and how
Fabric their mansions in the hardened milk,
Wonderful artists! J. PHILIPS.

But we are not now surprised to be told of animals twenty-seven millions of times smaller than a mite. Animalcules may be considered as visible, invisible, or microscopical. The *visible*, or such as may be discerned by the naked eye, are mites, divers species of insects, reptiles, and other vermin. The *invisible*, which are a species or order of animalcules *supposed* by naturalists, are such as escape the cognizance even of the best microscopes. In relation to these, they give many probable conjectures; and, indeed, reason and analogy afford some support to the existence of infinite imperceptible animalcules. The naked eye, it has been observed, takes in from the elephant to the mite; but there commences a new order reserved only for the microscope, which comprehends all these from the mite, to those twenty-seven millions of times smaller; and this order cannot be yet said to be exhausted, if the microscope be not arrived at its last perfection. The *microscopical* animalcules are such as are discoverable only by the assistance of a large magnifier: these, according to some, come under the denomination of invisible animalcules.

The extreme minuteness of these animalcules conceals them from the human eye unarmed. This is one of the great wonders of the modern philosophy. An object, a thousand times too little to be able to affect our sense, would, one would have thought, had been perfectly secure from our inspection. Yet we have extended our views over animals to whom these would be mountains. And it is strictly true, that most of our microscopical animalcules are so inconceivably small, that many thousands of them may dance on the point of a needle.

With respect to their structure and economy, animalcules are found of divers sorts; some formed like fish, others reptile, others hexapedal, some horned, &c. In several kinds, however small, it is easy to discover the form of their mouths, their proboscides, horns, &c. with the motions of their hearts, lungs, and other parts. Now, as every animalcule is an organized body, how delicate and subtile must the parts be, that are necessary to constitute it, and to preserve its vital actions! It is difficult to conceive how, in such a narrow compass, there should be contained a heart to be the fountain of life, muscles necessary to its motions, glands for the secretion of its fluids, a stomach and bowels to digest its food, and other innumerable members, without which an animalcule cannot subsist. But since every one of these members is also an organic body, they must have likewise parts necessary to their action: for they consist of fibres, membranes, coats, veins, arteries, nerves, and an almost infinite number of fine tubes like those, whose minuteness seems to exceed all efforts of imagination. But there are some parts that ought almost to be infinitely less than these, as the fluids that flow along these fine tubes, the blood, lymph, and animated spirits, whose subtilty, even in large animals, is incredible.

The celebrated naturalist Leewenhoeck, calculates that a thousand millions of animalcules, which are discovered in common water, are not altogether so large as a common grain of sand. Upon examining the male sperm of various animals, he discovered in many, infinite numbers of animalcules, not larger than those above-mentioned. In the milt of a single cod, there are more animals than there are men upon the whole earth; and yet a grain of sand is bigger than four millions of them. The white matter also, which sticks to our teeth, abounds with animalcules of various figures, to which vinegar is fatal; and it is known that vinegar contains animalcules in the shape of eels. In short, according to this author, there is scarce any thing that corrupts, without producing animalcules. Animalcules, moreover, are found to be the cause of various unpleasant disorders.

There is one remarkable circumstance, that we must not pass over in our contemplation of these minuter animals; which is, that they are found proportionably much stronger, more active and vivacious than large ones. The spring of a flea in its first leap, how vastly does it outstrip any thing of which greater animals are capable! A mite, how vastly swifter does it run than a race-horse! M. de L'Isle has given the computation of the velocity of a little creature scarce visible by its smallness, which he found to run three inches in half a second: now, supposing its feet to be the fiftieth part of a line, it must make 500 steps in the space of three inches; that is, it must shift its legs 500 times in a second, or in the ordinary pulsation of an artery.

How sweet to muse upon His skill displayed
(Infinite skill!) in all that he has made.
To trace in Nature's most minute design,
The signature and stamp of Power Divine;
Contrivance exquisite expressed with ease,
Where unassisted sight no beauty sees;
The shapely limb and lubricated joint
Within the small dimensions of a point;
Muscle and nerve miraculously spun,
His mighty work who speaks, and it is done;
Th' invisible in things scarce seen revealed;
To whom an atom is an ample field. COWPER.

In a word, the microscope endows us, as it were, with a new sense; unfolds the amazing operations of Nature, and displays to us wonders unimagined by former ages.

Who, a thousand years ago, would have thought it possible to distinguish myriads of living creatures in a single drop of water? That the purple tide of life, and even the globules of the blood should be seen distinctly, rolling through veins and arteries, smaller than the finest hair? That not only the exterior form, but even the internal structure of the bowels, and the motion of the fluids in a gnat or louse, should be rendered visible? Or, that numberless species of creatures should be made objects of vision, though so minute, that a million of them are less than a grain of sand?

These are noble discoveries, on which a new philosophy has been raised, that enlarges the capacity of the human understanding, and affords more sublime and just ideas than mankind had before, of the infinite power, wisdom, and goodness of the Great Creator.

It was an observation of the excellent Mr. Boyle, 'that his wonder dwelt not so much on Nature's clocks as on her watches.' And, indeed, if we compare the structure of an elephant, with that of a mite, we shall perceive the justness of his remark. With whatever degree of surprise, or even of terror, we may at first consider the huge bulk and prodigious strength of the elephant, we shall find our astonishment still greater, if we attentively examine the minute parts of the mite: for the latter has more limbs than the elephant; each of them (as I observed before) furnished with veins and arteries, nerves, muscles, tendons, and bones: it has eyes, a mouth, and a proboscis too (as well as the elephant) to take in its nourishment: a heart, moreover, to propel the circulation of the blood, a brain to supply nerves in every part, and the organs of generation as perfect as in the largest animal. Now, if the extreme minuteness of these parts is not merely surprising, but far above our utmost conception, what shall we say to those various species of animalcules, to which the mite itself, in size, is, as it were, an elephant?

How inconceivable it may appear, it is yet a fact, that a mite upon a cheese is as large and considerable, in proportion, as a man upon the earth. The little insects that feed upon the leaves of peach-trees are no inappropriate representation of oxen grazing in large pastures; and the animalcules, in a drop of water, swim about with as much freedom as whales do in an ocean. They have all equal room in proportion to their bulk.

Nor power alone confessed in grandeur lies,
The glittering planet, or the painted skies;
Equal, the elephant's or emmet's dress,
The wisdom of Omnipotence confess;
Equal the cumbrous whale's enormous mass,
With the small insect in the crowded grass;
The mite that gambols, in its acid sea,
In shape a porpoise, tho' a speck to thee!
E'en the blue down the purple plum surrounds,
A living world, thy failing sight confounds!
To thee a peopled habitation shows,
Where millions taste the bounty God bestows.

BOYSE.

The discoveries of the microscope suggest to us this important truth, that our ideas of matter, magnitude, and minuteness, are merely comparative. They are taken from ourselves and the things around us, beyond which, if we endeavour to extend them, they become very indistinct. The beginnings and endings, excessive greatness or extreme littleness, of things, are to us all perplexity and confusion.

'Let a man,' says Mr. Addison[1], 'try to conceive the different bulk of an animal which is twenty, from another which is a hundred times less than a mite; or to compare, in his thoughts, a length of a thousand diameters of the earth with that of a million; and he will quickly find that he has no different measures in his mind, adjusted to such extraordinary degrees of grandeur or minuteness. The understanding, indeed, opens an infinite space on every side of us; but the Imagination, after a few faint efforts, is immediately at a stand, and finds itself swallowed up in the immensity of the void that surrounds it. Our Readers can pursue a particle of matter through an infinite variety of divisions; but the Fancy soon loses sight of it, and feels in itself a kind of chasm, that wants to be filled with matter of a more sensible bulk. We can neither widen nor contract the faculty to the dimensions of either extreme. The object is too big for our capacity, when we would comprehend the circumference of a world, and dwindles into nothing when we endeavour after the idea of an atom.'

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[1] Spectator, No. 420.

But although the powers of the imagination be thus defective, the understanding is convinced by demonstration, and beholds this variety of wonders with astonishment and awe. Whether, with a Newton or a Herschel, we take the telescope, and compute the stupendous magnitude and velocity of a planet; or, with a Leewenhoeck or a Baker, survey, through a microscope, the structure and conformation of a mite; in each we are compelled to admire and adore the pervading wisdom and energy of the Creator:

In the Vast and the Minute
The unambiguous footsteps of the God,
Who gives its lustre to an insect's wing,
And wheels his throne upon the rolling worlds.
COWPER.

No. XXXIII.

A VIEW OF THE INSECT TRIBES.

We wonder at a thousand insect forms,
These hatched, and those resuscitated worms,
New life ordained, and brighter scenes to share,
Once prone on earth, now buoyant upon air.
COWPER.

INSECTS exhibit such an immense variety in figure, colour, and disposition of parts, that naturalists have found it necessary to arrange them into different tribes or families, distinguished from one another by certain peculiarities in the structure of their bodies.

The most general division of insects is derived from the circumstance of their having or wanting wings, and from the number and substances of which these instruments of motion are composed. They are distinguished from all other animals by many peculiarities of form. None of other classes have more legs than four. But most insects have six; and many of them have eight, ten, fourteen, sixteen, eighteen, and even a hundred legs. Beside the number of legs, insects are furnished with *antennæ*, or feelers. These feelers, by which they grope and examine the substances they meet with, are composed of a great number of articulations or joints. Linné, and some other naturalists, maintain, that the uses of these feelers are totally unknown. But the slightest attention to the manner in which some insects employ their feelers will satisfy us of at least one use they derive from these organs. When a wingless insect is placed at the end of a twig, or in any situation where it meets with a vacuity, it moves the feelers backward and forward, elevates, depresses, and bends them from side to side, and will not advance further, lest it should fall. If a stick, or any other substance, be placed within reach of the feelers, the animal immediately applies them to this new object, examines whether it be sufficient to support the weight of its body, and instantly proceeds in its journey. Though most insects are provided with eyes, yet the lenses of which they consist are so small and convex, that they can see distinctly but at small distances, and, of course, must be very incompetent judges of the vicinity or remoteness of objects. To remedy this defect, they are provided with feelers, which are perpetually in motion while the animals walk. By the same instruments, they are enabled to walk with safety in the dark.

No other animals but the insect tribes have more than two eyes; but some of them have four, and others, as the spider and scorpion, have eight eyes. In a few insects, the eyes are smooth; in all the others, they are hemispherical, and consist of many thousand distinct lenses. The eyes are absolutely immoveable: but this defect is supplied by the vast number of lenses, which, from the diversity of their positions, are capable of viewing objects in every direction. By the smallness and convexity of these lenses, which produce the same effect as the object glass of a microscope, insects are enabled to see bodies that are too minute to be perceived by the human eye. Another peculiarity deserves also our notice. No animals, except a numerous tribe of four-winged insects, have more than two wings.

With regard to sex, quadrupeds, birds, and fishes, are distinguished into males and females. But the bee and the ant furnish examples of neuters, which are absolutely barren: and the earthworm, and several shell animals, are hermaphro-

e, each individual possessing the prolific powers
both male and female.

It is likewise remarkable, that all winged in-
ts undergo three metamorphoses or changes of
m: the egg is discharged from the body of the
nale in the same manner as in other oviparous
imals. By a wonderful instinct, these seemingly
pid creatures uniformly deposit their eggs on
ch animal or vegetable substances as furnish
oper food for the worm or caterpillar, that is to
hatched by the heat of the sun. The worm or
terpillar is the first state. The bodies of cater-
lars are soft and moist. They have no wings,
d are totally deprived of the faculty of genera-
n. After continuing for some time in this rep-
state, they are transformed into a chrysalis,
ich is drier and harder than the caterpillar. The
rysales of some insects are naked, and those of
ers are covered with a silken web, spun by the
imals before their change is completed. In this
te, many of them lie motionless, and seemingly
nimate, during the whole winter. When the
ring or summer heats return, they burst from
ir last prison, and, from vile reptiles, are trans-
med into beautiful flies. In this perfect state
y are exceedingly active, fly about in quest of
ir mates, and, after propagating their species,
females deposit their eggs, and the same circle
animation and change perpetually goes round.

Poor insect! what a little day
  Of sunny bliss is thine!
And yet thou spread'st thy light wings gay,
  And bidd'st them, spreading, shine.

Thou humm'st thy short and busy tune,
  Unmindful of the blast;
And careless, while 'tis burning noon,
  How quick that noon be past.

A show'r would lay thy beauty low;
A dew of twilight be
The torrent of thy overthrow,
Thy storm of destiny!

Then spread thy little shining wing,
Hum on thy busy lay!
For *man*, like *thee*, has but his spring;
Like *thine*, it fades away! MRS. ROBINSON.

Behold the insect race, ordained to keep
The lazy sabbath of a half-year's sleep;
Entombed, beneath the filmy web they lie,
And wait the influence of a kinder sky.
When vernal sunbeams pierce their dark retreat,
The heaving tomb distends with vital heat;
The full-formed brood, impatient of their cell,
Start from their trance, and burst their silken shell;
Trembling, awhile they stand, and scarcely dare
To launch at once upon the untried air:
At length assured, they catch the favouring gale,
And leave their sordid spoils, and high in ether sail.
BARBAULD.

Waked by his warmer ray, the reptile young
Come winged abroad; by the light air upborn,
Lighter, and full of soul. From every chink,
And secret corner, where they slept away
The wintry storms; or rising from their tombs,
To higher life; by myriads, forth at once,
Swarming they pour; of all the varied hues
Their beauty-beaming parent can disclose.
Ten thousand forms! ten thousand different tribes!
People the blaze. To sunny waters some
By fatal instinct fly; where on the pool
They, sportive, wheel; or, sailing down the stream,
Are snatched immediate by the quick-eyed trout,
Or darting salmon. Through the green-wood glade
Some love to stray; there lodged, amused and fed,
In the fresh leaf. Luxurious, others make
The meads their choice, and visit every flower,
And every latent herb: for the sweet task,
To propagate their kinds, and where to wrap,
In what soft beds, their young yet undisclosed,
Employs their tender care. Some to the house,
The fold, and dairy, hungry, bend their flight;

Sip round the pail, or taste the curdling cheese;
Oft, inadvertent, from the milky stream
They meet their fate; or, weltering in the bowl,
With powerless wings around them wrapt, expire.
THOMSON.

There is another peculiarity in the structure of insects. They are deprived of bones. But that defect is supplied, in some, by a membraneous or muscular skin, and, in others, by a crustaceous or horny covering. In this circumstance, insects resemble the shell-animals, whose bones constitute the external parts of their bodies.

In general, the bodies of insects are composed of a head, trunk, and abdomen. The head is commonly attached to the trunk by a joint or articulation. Beside eyes, feelers, and mouth, the heads of some insects are furnished with *palpi* fixed to the mouth; and they are either four or six in number. Each of them consists of two, three, or four joints, and are often mistaken for the *antennæ*, or feelers. These instruments seem to serve the animals instead of hands; for they employ them to bring the food to their mouths, and to keep it steady while eating. It is asserted by Linné, and other naturalists, that the heads of insects are destitute of brains, nostrils, and ears. The minuteness of the animals under consideration may have hitherto prevented us from distinguishing these organs. If they want a brain, it is certain that their sense of seeing is acute; and we know that they are amply supplied with nerves, which produce the same effects as the brain in larger animals. If they are deprived of nostrils, the slightest attention must convince us, that some of them possess the sense of smelling in a very high degree. Upon any other supposition, how should the different species of flies, the moment they escape from the chrysalis state, distinguish, and directly approach, the different animal and vegetable substances Nature has destined for their respective nourishment? A piece of meat is no sooner exposed to the air than it is covered with flesh flies, upon which they both feed and deposit their eggs. Without this sense, how should wasps, and other flies, be allured from considerable distances into bottles encrusted with honey or molasses? These, and similar actions, cannot be effects of sight; for the distance, the minuteness, and frequently the position of the food, render it impossible for the eye to discover those substances to which they instantly resort.—With regard to hearing, it is more difficult to determine whether insects be endowed with this sense. We can judge of it, not by the knife of the anatomist, but by the affections and motions of the animals themselves. From several trials made on house-flies, it is thought that if these animals are really deprived of ears, they are endowed with an analogous sense, though we are ignorant of its situation.

Naturalists have limited the senses of insects to those of seeing and feeling. But the above remarks render it probable that flies possess likewise the senses of smelling and of hearing: neither should the sense of taste be denied them; for, though they may be assisted by smelling to discover and select their food, we cannot suppose that Nature has denied them the pleasure which other animals so universally derive from eating. Besides, an agreeable sensation, similar to that of taste, must accompany an action which removes the pain arising from hunger.

The mouth of insects is generally placed in the under part of the head; but, in some, it is situate in the breast. The jaws, instead of being horizontal, are often transverse, and furnished with teeth. The greater number of winged insects are provided with a proboscis or trunk, an instrument by which they extract the juices from animal or vegetable substances. The proboscis of insects is a machine of a very complicated nature. In butterflies, the proboscis is situated precisely between the two eyes. Though some of them exceed three inches in length, they occupy but a small space. When a butterfly is not in quest of food, the proboscis is rolled up in a spiral form, similar to that of a watch-spring, each successive ring covering the one which precedes. The substance of the proboscis has some resemblance to that of horn. It tapers from the base to the extremity. It is composed of two similar and equal parts, each of which is concave, and, when joined, form three distinct tubes. Reaumur has rendered it probable, that these tubes enable the animals to extract the juices of plants, to conduct air into their bodies, and to convey the sensation of smelling. Hence the proboscis of insects is an instrument which serves them for a mouth, a nose, and a windpipe.

The upper part of the trunk or body of insects is called the thorax, and the under part the abdomen or belly. The abdomen contains the stomach and other viscera. It consists of several rings or segments, and is perforated with spiracula, or tubes, which supply the want of lungs. The abdomen is terminated by the tail, which, in some insects, is armed with a sting, a forceps, a bristle, or a kind of claw with a moveable thumb.

The legs are composed of three parts, connected to each other by joints, and represent the thighs, shanks, ankles, and feet of larger animals.

The wings of insects are so diversified in number, consistence, and colour, that Linné has made the the foundation of the seven orders or divisions i which he divides this numerous class of anim Some insects are furnished with four, and ot with two wings, and some of them are entirely destitute of these instruments of motion.

The first order Linné distinguishes by the name of *coleoptera*, or those insects with four wings whose upper pair consist of a hard, crustaceous, or horny substance. These cover and defend the under pair, which are of a more soft and flexible texture. This order comprehends the whole of what is properly called *scarabæi*, or the beetle tribe. Like other winged insects, all the beetles live for some time in the form of caterpillars, or grubs:

> See the proud giant of the beetle race;
> What shining arms his polished limbs enchase!
> Like some stern warrior formidably bright
> His steely sides reflect a gleaming light:
> On his large forehead spreading horns he wears,
> And high in air the branching antlers bears:
> O'er many an inch extends his wide domain,
> And his rich treasury swells with hoarded grain.
>
> BARBAULD.

It is here worthy of remark, that the same animals, when in the state of caterpillars, live in a different manner, and feed on substances of a very different kind from those they consume after their transformation into flies. The caterpillars of the garden-beetle, cockchafer, &c. lead a solitary life, under ground, and consume the roots of plants. Those of others feed upon putrid carcases, every kind of flesh, dried skins, rotten wood, the dung of men and quadrupeds, and the small insects called pucerons, or vine-fretters. But after their transformation into flies, many of the same animals, which formerly fed upon dung and putrid carcases, are nourished by the purest nectareous juices extracted from fruits and flowers. The creatures themselves, with regard to what may be termed individual animation, have suffered no alteration.

But the fabric of their bodies, their instruments of motion, and the organs by which they take their food, are materially changed. This change of structure, though the animals retain their identity, produces the greatest diversity in their manners, their economy, and the powers of their bodies. In the caterpillar state, these animals are extremely voracious, and, in many instances, acquire a greater magnitude than they possess after transformation; but they are incapable of multiplying their species, and of receiving nourishment from the same kinds of food. Besides, many caterpillars, previous to their transformation, live even in a different element. The ephemeron fly, when in the caterpillar state, lives no less than three years in the water, and extracts its nourishment from earth and clay. After transformation, this animal seldom exists longer than one day, during which the species is propagated, and myriads of eggs are deposited on the surface of the water. These eggs produce worms or caterpillars, and the same process goes perpetually round.

The second order of insects, denominated *hemiptera,* have likewise four wings. But the upper pair, instead of being hard and horny, rather resemble fine vellum. They cover the body horizontally, and do not meet in a direct line, forming a ridge or suture, as in the beetle tribe. The whole of this order are furnished with a proboscis or trunk for extracting their food.

This order comprehends several genera or kinds, some of which I shall mention in a cursory manner. —The *blatta,* or cockroach, is an animal which avoids the light, and is particularly fond of meal, bread, putrid bodies, and the roots of plants. It frequents bakers shops and cellars, and flies the approach of danger with great swiftness.—The head of the *mantis*, or camel-cricket, appears from its continual nodding motion, to be slightly attached to the thorax. This insect is regarded by the Africans as a sacred animal; because it frequently assumes a praying or supplicating posture, by resting on its hind feet, and elevating and folding the first pair.—The *gryllus* comprehends a number of species, some of which are called grasshoppers, others locusts, and others crickets. The caterpillars of the grylli, have a great resemblance to the perfect insects, and, in general, live under ground. Many of these insects feed upon the leaves of plants. Others, which live in houses, prefer bread, and every kind of farinaceous substance.—The foreheads of several of the genus, called *fulgora*, or fire-fly, especially of those that inhabit China, and other hot climates, emit a very lively shining light during the night, which often alarms those who are unacquainted with the cause of the appearance.—To this insect Thomson alludes in his view of the torrid zone:

> From Menam's orient stream, that nightly shines
> With insect lamps.

And Mrs. Barbauld:

> Some shoot like living stars, athwart the night,
> And scatter from their wings a vivid light,
> To guide the Indian to his tawny loves,
> As thro' the woods with cautious steps he moves.

The caterpillars of some of the genus called *cicada*, or flea-locust, discharge a kind of froth or saliva from the anus and pores of the body, under which they conceal themselves from the rapacity of birds and other enemies.—The *papa*, or water scorpion, frequents stagnant waters. It lives chiefly on aquatic insects, and is exceedingly voracious.—Many species of the *cimex*, or bug, feed upon the juices of lants, and others upon the blood of animals. Some f them are found in waters, and others frequent ouses, among which, though it wants wings, is he bed-bug, a pestiferous insect, which is too well nown, and too generally diffused. The bugs differ om other insects by their softness; and most of hem emit a very fetid smell.—The insect called *phis*, or tree-louse, is very common. There are a reat many species, denominated from the trees and lants which they infest: they are viviparous in ummer, and oviparous in autumn. Numbers of hose called vine-fretters are devoured by the ants, n account, it is supposed, of a sweet liquor with which their bodies are perpetually moistened. The aterpillars of the *chermes*, have six feet, and are generally covered with a hairy or woolly substance. The winged insects leap or spring with great agility, and infest a number of different trees and plants: the females, by means of a tube at the termination of their bodies, insert their eggs under the surface of the leaves, and the worms, when hatched, give rise to those tubercles, or galls, with which the leaves of the ash, the fir, and other trees, are sometimes almost entirely covered.—I shall proceed further in this subject, and finish the remaining orders of the insect tribes in my next paper.

No. XXXIV.

A VIEW OF THE INSECT TRIBES, CONTINUED.

> What atom-forms of insect life appear!
> And who can follow nature's pencil here?
> Their wings with azure, green, and purple glossed,
> Studded with coloured eyes, with gems embossed,
> Inlaid with pearl, and marked with various stains
> Of lively crimson thro' their dusky veins.
>
> BARBAULD.

LINNE'S third order of insects, termed *lepidoptera*, has four wings, and consists of three genera only; but the species comprehended under them are exceedingly numerous. All butterflies and moths belong to this order. Their wings are covered with a farinaceous powder, or rather with a kind of scales or feathers, disposed in regular rows, nearly in the same manner as tiles are laid upon the roofs of houses. The elegance, the beauty, the variety of colours exhibited in their wings are produced by the disposition and different tinctures of these minute feathers. The insects of this order, on account of their beauty and easy preservation, have always been the favourites of collectors, and particularly of those of the female sex. When the feathers are rubbed off, the wings appear to be nothing more than a naked, and often a transparent membrane. The feelers of the papilio, or butterfly, are thickest at their extremity, and often terminate in a kind of knob, or head. Their wings, when sitting, or at rest, are erect, their extremities join each other above the body, and the animals fly about, in quest of food and of their mates, during the day.—The moths are divided into two genera, the one called *sphinx*, or hawk-moth, and the other *phalæna*, or moth. The feelers of the *sphinx* are thicker in the middle than at the extremities, and their form in some measure resembles that of a prism. The wings are, in general, deflected, their outer margins declining toward the sides. They fly about early in the morning, and after sunset; and, by means of their proboscis, like the butterflies, they suck the juices of plants.—The feelers of the *phalæna* are setaceous, and taper from the base to the point. When at rest, their wings are commonly deflected; and they fly during the night. Previous to their transformation, the caterpillars of the whole of this genus spin webs for covering and protecting the animals while in the chrysalis state. From a species of this tribe mankind have derived one of the greatest articles of luxury and of commerce which now exists in the world. That seemingly contemptible, and disgusting reptile the silkworm, in its passage from the caterpillar to the chrysalis state, produces those splendid materials which adorn the thrones of princes, and add dignity and lustre to female beauty.

The fourth order of insects is distinguished by the name *neuroptera*. They have four wings, which are membranaceous, naked, and so interspersed with delicate veins, that they have the appearance of beautiful net-work. Their tail has no sting; but that of the male is frequently furnished with a kind of forceps or pincers. To this order belongs the *libellula*, or dragon-fly, an insect of very splendid and variegated colours. It is a large and well known fly, and frequents rivers, lakes, pools, and stagnating waters, in which the females deposit their eggs. Under the same order is comprehended the *phryganea*, or spring-fly: the caterpillars of this genus live in the water, and are covered with a silken tube. They have a very singular aspect; for, by means of a gluten, they attach to the tubes in which they are inclosed small pieces of wood, sand, gravel, leaves of plants, and not unfrequently live on testaceous animals, all of which they drag along with them. They are very commonly found in salads of the water-cress; and, as they are often entirely covered with green leaves, they have the appearance of animated plants. They are in great request among fishermen, by whom they are distinguished by the name of stone or cod-bait. The fly, or perfect insect, frequents running waters, in which the females deposit their eggs.

The fifth order is termed *hymenoptera*. In general the insects belonging to this order have four membranaceous and naked wings. In some of the genera, however, the neuters, and, in others, the males, or even, the females, have no wings. Their tails, except in the male sex, are armed with a sting. The female of the *cynips*, an insect belonging to this order, inserts her eggs into the leaves of the oak, and the caterpillars produced from them give rise to the galls employed in the composition of ink.—This order likewise includes the wasp, the bee, and the ant. Many of the wasp kind, like the bees, live in society, make combs in which the females deposit their eggs, and feed their caterpillars with an inferior species of honey. Others of them construct a separate nest for each individual egg.—The bee is an insect too well known to require a particular description. The males have no sting; but the females, and the drones, or neuters, have a very sharp pointed sting concealed in their abdomen. The female of the honey bee is much larger than the male, or the neuter; her feelers contain fifteen articulations; and her abdomen, composed of seven segments, is much longer than her wings. The feelers of the male contain only eleven articulations. The neuters re much smaller than the males or females, and heir feelers consist of fifteen articulations.—The ale and female ants are armed with a sting, which s concealed within the abdomen. The males and emales are furnished with wings, but the neuters re deprived of these instruments of motion. The nts live in societies which are composed of males, emales, and neuters: the males are much smaller han the females and neuters. Soon after the males nd females propagate the species, they all die: some f the neuters, however, survive the winter; but hey remain in their habitation without movement, r discovering any signs of life. From these cir-umstances in the history of ants, it is apparent, hat the industry and sagacity so long and so uni-ersally ascribed to these little animals could be f no use either to themselves or their progeny. The females, after depositing their eggs, take no fur-her care of their offspring. But, what is singular, he important office of feeding the caterpillars, after he eggs are hatched, is left entirely to the neuters. This affectionate and assiduous attention of the neu-ers to a progeny neither begot nor brought forth by hem, is so astonishing, so contrary to the general conomy of Nature, that no reasoning or theory can ccount for a fact so uncommon, till further disco-eries shall be made in the history of these surprising nimals. What is still more singular, after the ca-erpillars are transformed into the chrysalis state, the euters are incessantly and anxiously employed in reserving the chrysalis from humidity when the eather is wet, and in exposing them to the armth of the sun when it is fair. These chrysales re larger than the animals themselves, and yet they arry them off with ease and rapidity.

The sixth order of insects is termed *diptera* or wo-winged insects. The different species of this rder, beside wings, are furnished with what is called a halter, or a poiser, which is situate under each wing, and is terminated by a knob. This order comprehends ten genera and a multitude of species. The caterpillars of the *æstrus*, or gadfly, lie concealed in the skins of cattle, where they are nourished during the whole winter. The perfect insects are frequent wherever horses, cows, or sheep, are grazing. Some of them deposit their eggs in the skins of cows or oxen; others deposit them in the intestines of horses, to which they get access by the anus; and others in the nostrils of sheep. In these habitations, the caterpillars reside till they are full grown, when they throw themselves down to the earth, and generally pass the chrysalis state under the first stone they meet with.—The mouth of the *musca*, or common fly, consists of a soft, fleshy proboscis, with two lateral lips. The caterpillars of some of this genus devour the pucerons; others consume all kinds of putrid flesh; others are found in cheese; others in the excrements of different animals; and many of them live in the water, and prefer that which is most corrupted and muddy.—The mouth of the *culex*, or gnat, consists of a flexible sheath, inclosing four bristles, or pointed stings. The feelers of the female gnat are plain like a thread; but those of the male are beautifully feathered. The caterpillars of this genus are commonly found in stagnant waters. The gnats generally frequent woods and marshy places. The females, in particular, are very troublesome, and sting severely.—The feet of the *hippobosca*, or horsefly, are armed with a number of nails or crotchets: in some species, the wings cross each other; in others, they are open. The horseflies frequent woods and marshy grounds, and are extremely incommodious to birds and quadrupeds, whose blood is the only food of these insects.

The seventh, and last order of insects Linné denominates *aptera*, because neither males nor females are furnished with wings. This order comprehends thirteen genera, and a great number of species, many of which are very offensive and noxious to the human species. The *pediculus*, or louse, has six legs, two prominent eyes, and its mouth contains a sting or sucker, by which it extracts blood and other juices from the bodies of animals. Though almost every different animal is infested with a peculiar species of lice, the specific characters of very few of them have hitherto been ascertained. Lice are of various forms; some of them oval, others oblong, and others long and slender. They are oviparous animals, and their eggs are large in proportion to the size of their bodies. Before they arrive at maturity, they change their skin several times.—The *pulex*, or flea, has likewise six legs, the articulations of which are so exceedingly elastic, that the animal is enabled by their means, to spring to a surprising distance. It has two fine eyes, and its body is covered with crustaceous scales. The flea is the only insect belonging to this order which undergoes a transformation similar to that of the former orders: all the other wingless insects are produced in a perfect state, either by the mother or from eggs. The caterpillars of the flea have forked tails, and are very small and lively. They may be nourished in boxes, and fed with flies, which they greedily devour. Before changing into the chrysalis state, they live fourteen or fifteen days in the form of caterpillars.—The genus called *aranea*, or spider, comprehends a great many species. The spider has eight feet, and an equal number of immoveable eyes. The chief prey of the spider is flies, animals whose motions are extremely quick and desultory. To enable the spider to observe their movements in every direction, it is furnished with eight eyes, the position of which merits a tion: two of them are placed on the top of the head, other two on the front, and two on each side. The mouth is armed with two hooks or fangs, by which it seizes and kills its prey. Round the anus there are several muscular instruments, shaped like nipples or teats: each of these contain about a thousand tubes or outlets for threads so extremely minute, that many hundreds of them must be united before they form one of those visible ropes of which the spider's web is composed. The figure of the web varies according to the species, or the situation the animal chooses for its abode. After the web is completed, some species reside in the centre, and others occupy the extremity of their habitations, where they lie in ambush, with astonishing patience, till a fly is accidentally entangled. The spider, from the vibration of the threads, perceives his prey, rushes forth from his cell, instantly seizes it with his fangs, devours its vitals, and afterward rejects the exhausted carcase. Spiders prey upon all weaker insects, and even upon their own species:

> But chief to heedless flies the window proves
> A constant death; where, gloomily retired,
> The villain spider lives, cunning, and fierce,
> Mixture abhorred? Amid a mangled heap
> Of carcases, in eager watch he sits,
> O'erlooking all his waving snares around.
> Near the dire cell the dreadless wanderer oft
> Passes, as oft the ruffian shows his front:
> The prey at last ensnared he dreadful darts,
> With rapid glide, along the leaning line;
> And, fixing in the wretch his cruel fangs,
> Strikes backward grimly pleased: the fluttering wing
> And shriller sound declare extreme distress,
> And ask the helping hospitable hand. THOMSON.

The scorpion is a venomous insect, and a native of warmer climates than those of the north of Europe. It has eight feet, and two claws, the last of which are situate on the forepart of the head. Like the spider, the scorpion has eight eyes, three of which are placed on each side of the breast, and the other two on the back. The tail is long, jointed, and terminates in a sharp crooked sting. The venom of the scorpion is more destructive than that of any other insect; and is sometimes fatal in Africa and other hot regions.

Such are the divisions into which insects have been classed according to the Linnean system, and such is their structure and conformation. There are many other curious particulars concerning this wonderful part of the creation, which shall be the subject of future discussion. In the mean time, I shall conclude this paper, with a beautiful comparison from the moral Thomson:

> Thick in yon stream of light, a thousand ways,
> Upward, and downward, thwarting, and convolved,
> The quivering nations sport; till tempest winged,
> Fierce Winter sweeps them from the face of day.
> Ev'n so luxurious men, unheeding pass
> An idle summer life in fortune's shine,
> A season's glitter! Thus they flutter on
> From toy to toy, from vanity to vice;
> Till blown away by death, oblivion comes
> Behind, and strikes them from the book of life.

No. XXXV.

ON THE TRANSFORMATION OF INSECTS.

Where greatness is to Nature's works denied,
In art and beauty it is well supplied:
In a small space the more perfection's shown,
And what is exquisite in little's done,
'Tis Nature's smallest products please the eye,
While greater births pass unregarded by,
Her monsters seem a violence to sight:
They're formed for terror, insects to delight.
Thus, when she nicely frames a piece of art,
Fine are her strokes, and small in every part.
No labour can she boast more wonderful
Than to inform an atom with a soul;
To animate her little beauteous fly,
And clothe it in her gaudiest drapery. YALDEN.

IN my two former papers I took a view of the divisions into which insects have been classed, according to the Linnean system. I am now to give a more particular account of what I have hitherto only incidentally mentioned—the various and wonderful transformations which they undergo.

All winged insects, without exception, and many of those which are destitute of wings, must pass through several changes before the animals arrive at the perfection of their natures. The appearance, the structure, and the organs of a caterpillar, a chrysalis, and a fly, are so different, that, to a person unacquainted with their transformations, an identical animal would be considered as three distinct species. Without the aid of experience, who could believe that a butterfly, adorned with four beautiful wings, furnished with a long spiral proboscis, instead of a mouth, and with six legs, proceeded from a disgusting caterpillar, provided with jaws and teeth, and fourteen feet? Without experience, who could imagine that a long, white, smooth, soft worm, hid under the earth, should be transformed into a black crustaceous, beetle, having wings covered with horny cases?

Beside their final metamorphosis into flies, caterpillars undergo several intermediate changes. All caterpillars cast or change their skins more or less frequently according to the species. The silkworm, previous to its chrysalis state, casts its skin four times. The first skin is cast on the 10th, 11th, or 12th day, according to the nature of the season; the second in five or six days after; the third in five or six days more; and the fourth and last in six or seven days after the third. This changing of skin is not only common to all caterpillars, but to every insect whatever. Not one of them arrives at perfection without casting its skin at least once or twice. The skin, after it is cast, preserves so entirely the figure of the caterpillar in its head, teeth, legs, colour, hair, &c. that it is often mistaken for the animal itself. A day or two before this change happens, caterpillars take no food; they lose their former activity, attach themselves to a particular place, and bend their bodies in various directions, till, at last, they escape from the old skin, and leave it behind them. The intestinal canal of caterpillars is composed of two principal tubes, the one inserted into the other: the external tube is compact and fleshy; but the internal one is thin and transparent. Some days before caterpillars change into the chrysalis state, they void, along with their excrement, the inner tube which lined their stomach and intestines. When about to pass into the chrysalis state, which is a state of imbecility, they select the most proper places and modes of concealing themselves from their enemies. Some, as the silkworm and many others, spin silken webs or cords round their bodies, which completely disguise the animal form. Others leave the plants upon which they formerly fed, and hide themselves in little cells which they make in the earth. The rat-tailed worm abandons the water upon the approach of its metamorphosis, retires under the earth, where it is changed into a chrysalis, and, after a certain time, bursts from its seemingly inanimate condition, and appears in the form of a winged insect. Thus the same animals pass the first and longest period of their existence in the water, another under the earth, and the third and last in the air. Some caterpillars, when about to change into a chrysalis state, cover their bodies with a mixture of earth and of silk, and conceal themselves in the loose soil. Others incrust themselves with a silky or glutinous matter, which they push out from their mouths, without spinning it into threads. Others retire into the holes of walls or decayed trees. Others suspend themselves to the twigs of trees, or to other elevated bodies, with their heads undermost. Some attach themselves to walls, with their heads higher than their bodies, but in various inclinations: and others choose a horizontal position. Some fix themselves by a gluten, and spin a rope round their middle to prevent them from falling. Those which feed upon trees attach themselves to the branches, instead of the leaves, which are less durable, and subject to a greater variety of accidents. The colours of the caterpillars give no idea of those of the future flies.

In general, the figure of chrysales approaches to that of a cone, especially in their posterior part. When under this form, the insect seems to have neither legs nor wings. It is incapable either of walking or of crawling, It takes no nourishment, because it has no organs suited to that purpose; yet, in some species, life is continued for several months before their last metamorphosis takes place. In a word, it seems to be a lifeless mass. But, upon a more attentive observation, it possesses the power of bending upward and downward the posterior part of its body. The skin, or exterior covering, of those which do not spin cods, seems to be of a cartilaginous nature. It is commonly smooth and shining; but in some species it is more or less covered with hair and other rugosities. Though chrysales differ both in figure and colour, their appearances are by no means so various as those of the caterpillars from which they are produced. The colour of some chrysales is that of pure gold, from which circumstance the whole have received their denomination. For the same reason they are called *aureliæ* in Latin. Some are brown, others green; and, indeed, they are to be found of almost every colour and shade.

The life of winged insects consists of three principal periods, which present very different scenes to the student of Nature. In the first period, the insect appears under the form of a worm or caterpillar. Its body is long, cylindrical, and consists of a succession of rings, which are generally membraneous, and encased within each other. By the aid of its rings, or of crotchets, or of several pair of legs, it crawls about in quest of food; and its movements are, in some species, remarkably quick. Its head is armed with teeth, or pincers, by which it eats the leaves of plants or other kinds of food. In this state, it is absolutely deprived of sex, and, consequently, of the power of multiplication. Its blood moves from the tail toward the head. It respires either by small apertures placed on each side of its body, or by one or several tubes situate on its posterior part, which have the resemblance of so many tails. In the second period, the insect appears under the form of a nymph, or that of a chrysalis. When an insect, *after throwing off* the skin of the caterpillar, exhibits all its external parts, only covered with soft and transparent membranes, it is called a nymph: but, when to these membranes is added a common and crustaceous covering, it receives the name of a chrysalis. While in a state of a nymph, or of a chrysalis, insects, in general, are totally inactive, and seem not to possess any powers of life. They can make no use of their eyes, their mouth, or any of their members; for they are all imprisoned by coverings more or less strong. Deprived of the faculty of motion, they remain fixed in those situations which they have chosen for their temporary abode, or where chance has placed them, till their final metamorphosis into flies. Some of them, however, are capable of changing place; but their movements are slow and painful. Their blood circulates, but in a contrary direction from what takes place in the caterpillar state; for it proceeds from the head toward the tail. Respiration continues to go on, but the organs are differently situated. In the caterpillar, the principal organs of respiration were placed at the posterior part of the body; but now these same organs are to be found at the anterior part of the animal. In the third period, the insect has acquired that perfect organization which corresponds to the rank it is to hold in the scale of animation. The bonds of the nymph, or the chrysalis, are now burst asunder, and the insect commences a new mode of existence. All its members, formerly soft, inactive, and folded up in an envelope, are expanded, strengthened, and exposed to observation. Under the form of a worm or caterpillar, it crawled; under that of a nymph, or chrysalis, its power of motion was almost annihilated; under the last form, it is furnished with six springy legs, and two or four wings with which it is enabled to fly through the air. Instead of teeth or pincers, with which it divided a gross aliment, it has now a trunk by which it extracts the refined juices of the most delicate flowers. Instead of a few smooth eyes which it possessed in the worm or caterpillar state, the new insect is furnished with both smooth and convex eyes, to the number of several thousands.

The internal parts of the insect have likewise undergone as many changes as the external. The texture, the proportions, and the number of the viscera, are greatly altered. Some have acquired an additional degree of consistence; others, on the contrary, are rendered finer and more delicate. Some receive a new form, others are entirely annihilated. Lastly, some organs in the perfect insect, which seemed formerly to have no existence, are unfolded, and become visible. The most important of this last kind are the organs of generation. The caterpillar, the nymph, and the chrysalis, were of no sex; but, after transformation, both sexes are distinguishable, and the animals are capable of multiplying their species.

But there are some examples of transformations which deviate from the common mode. Some insects hold a middle rank between those which preserve their original figure during life, and those that suffer transformations. Their existence is divided into two periods only: they walk in the first, and fly in the second. Thus their only metamorphosis consists of the addition of wings, the growth and expansion of which are performed without any considerable alteration in the figure of their bodies.

There is not a law established among organized bodies which seems to be so universal, as that all of them grow, or augment in size, after birth till they arrive at maturity. If a hen were to bring forth an egg as large as her own body, and if this egg, when hatched, were to produce a bird of equal dimensions with either of the parents, it would be considered as a miracle. But the spider-fly, so denominated from its figure, affords an example of a similar prodigy. This fly actually lays an egg, from which a new fly is hatched that is as large and as perfect as its mother. This egg is roundish, is at first white, and afterward assumes a shining black colour. Upon a more accurate examination, however, this production was found to be an egg only in appearance. When the envelope is removed, instead of a gelatinous substance, the new insect, furnished with all its members, is discovered. But this discovery does not render the fact the less wonderful. All winged insects undergo their different transformations after being expelled from the bodies of their mothers, and receive great augmentations of size before their metamorphosis into the nymph or chrysalis state, after which their growth stops. But the spider-fly affords an instance of an insect transformed in the belly of its mother, and which grows no more after it escapes from its envelope. The fact is fully authenticated by Reaumur, Bonnet, and other naturalists.

The worm from which the *tipula*, or crane-fly, is produced, is perfectly smooth. Immediately before its transformation it retires under ground. After this metamorphosis, the surface of the nymph is furnished with a number of prickles. By means of these prickles, the nymph, when about to be transformed into a fly, raises itself in its hole till the chest of the insect is above ground. The fly then bursts its prison, mounts into the air, and leaves its former covering behind in the earth.

Many species of flies deposit their eggs in the leaves and different parts of plants. Soon after the egg is inserted into the leaf, a small tubercle begins to appear, which gradually increases in magnitude till the animal is hatched, and has passed through its different transformations. These tubercles are known by the name of galls, and are very different in their form, texture, colour, and size. Galls of every kind, however, derive their origin from the stings of insects, which generally belong to the class of flies. The female fly, by means of her sting, makes incisions in the leaves or branches of a tree, and in each incision she lays an egg. This egg is at first extremely minute; but it soon acquires a considerable bulk, and the gall has arrived at its full size before the worm is hatched. This gall seems to be analogous to the membranes which invest a foetus, and expands in all directions in proportion to its growth. That the eggs of oviparous animals grow while in the ovarium is universally known; but it is singular that the eggs of gall-flies should grow after being separated from the body of the mother. These eggs must undoubtedly be furnished with external vessels, or a kind of roots, by which they extract juices from the internal cavity of the gall. Malpighi ascribes the origin of galls to a corrosive liquor introduced by the fly into the wound. But Reaumur, to account for the growth of a gall, thinks it unnecessary to have recourse to any supposed poisonous fluids, and attributes it to the superabundant nutritious juices derived to that particular part by the continual action of the absorbent vessels of the egg, joined to its heat, which may be compared to a little fire placed in the centre of the tumour.

I shall not inquire whether these causes are sufficient to explain the growth of galls. But, that the eggs deposited by the flies augment in size; that worms proceed fron them; that these worms are nourished, and live a certain time imprisoned in the galls; that they are there transformed into nymphs or chrysales; and, lastly, that they are metamorphosed into winged insects, which, by gnawing an aperture through the gall, take their flight in the air; are known and incontestible facts. Examine the common oak-galls, or those of any other tree; if any of them happen to have no aperture, cut them gently open, and you are certain to find an egg, a worm, a chrysalis, or a fly; but in such as are perforated, not a vestige of an animal is discoverable.

Some caterpillars, when about to transform, make a belt pass round their bodies. This belt is composed of an assemblage of silken threads spun by themselves, the ends of which they paste to the twigs of bushes, or other places where they choose to attach their bodies. They likewise fix their hind legs in a tuft of silk. After transformation, the chrysales remain fixed in the same manner as before their metamorphosis. The belt is loose, and allows the chrysalis to perform its slow and feeble movements.

The whole moth-kind, as well as the silk-worm, immediately before their transformation into the chrysalis state, cover their bodies with a cod or clue of silk, though the nature of the silk, and their mode of spinning, are very different. The cod of the silk-worm is composed of pure silk, and produced by numberless circumlocutions and zigzags of the same thread. Their figure is generally oval, which necessarily results from that of the animal's body upon which they are moulded. When spinning, they twist their bodies into the form of an S. The silk is spun by an instrument situate near the mouth of the insect. The silky matter, before it is manufactured by the spinning instrument, appears under the form of a gum almost liquid, which is contained in two large reservoirs contorted like the intestines of larger animals, and which terminate at the spinning instrument by two parallel and slender conduits. Each conduit furnishes matter for one thread. The spinning instrument, as is evident when viewed by the microscope, unites the two threads into one. Thus a thread of silk, which has the appearance of being single, is in reality double, and spun with great dexterity. Some writers, who delight in the marvellous, ascribe foresight to the silk-worm in spinning its cod. The silk-worm, it must be acknowledged, acts as if it foresaw the approaching event. But the truth is, that, when the animal has acquired its full growth, its reservoirs of silk are completely filled. It then seems to be strongly stimulated to evacuate this glutinous matter. Its different movements and attitudes, while discharging the silk, produce those oval bundles which clothe and ornament vast numbers of the human species.

Another species of caterpillar constructs its cod in the form of a boat with the keel uppermost; but it consists not entirely of pure silk. The animal, with its teeth, detaches small triangular pieces of bark from a bush or tree. These pieces of bark it pastes upon its body by means of a glutinous or silky substance, and they constitute a principal part of its cod.

Another species works also in wood, though not with equal art as the former. Its cod is composed entirely of small irregular fragments of dried wood. These fragments the animal has the address to unite together, and to form of them a kind of box which covers and defends its whole body. It accomplishes this purpose by moistening, for some moments, the pieces of wood in its mouth, and then attaches them to each other by a glutinous substance. Of this mixture the caterpillar forms a cod, the solidity of which is nearly equal to that of wood.

The most solitary of all insects are those which live in the internal parts of fruits. Many of them *undergo their* metamorphosis in the fruit itself, which affords them both nourishment and a safe retreat. They dig cavities in the fruit, which some of them either line with silk, or spin cods. Others leave the fruit, and retire to be transformed in the earth.

The metamorphosis of insects has been regarded as a sudden operation, because they often burst their shell or silky covering quickly, and immediately appear furnished with wings. But, by more attentive observation, it has been discovered, that the transformation of caterpillars is a gradual process from the moment the animals are hatched till they arrive at a state of perfection. Why, it may be asked, do caterpillars so frequently cast their skins? The new skin, and other organs, were lodged under the old ones, as in many tubes or cases, and the animal retires from these cases, because they have become too strait. The reality of these encasements has been demonstrated by a simple experiment. When about to molt or cast its skin, if the foremost legs of a caterpillar are cut off, the animal comes out of the old skin deprived of these legs. From this fact, Reaumur conjectured, that the chrysalis might be thus encased, and concealed under the last skin of the caterpillar. He discovered that the chrysalis, or rather the butterfly itself, was inclosed in the body of the caterpillar. The proboscis, the antennæ, the limbs, and the wings of the fly, are so nicely folded up, that they occupy a small space only under the first two rings of the caterpillar. In the first six limbs of the caterpillar are encased the six limbs of the butterfly. Even the eggs of the butterfly have been discovered in the caterpillar long before its transformation.

From these facts it appears, that the transformation of insects is only the throwing off external and temporary coverings, and not an alteration of the original form. Caterpillars may be considered as analogous to the foetuses of men and of quadrupeds. They live and receive nourishment in envelopes till they acquire such a degree of perfection as enables them to support the situation to which they are ultimately destined by Nature[1].

No. XXXVI.

ON TRANSFORMATION IN GENERAL.

Omnia transformant sese in miracula rerum.
VIRGIL.

From form to form they pass in wondrous change.

The transformation of caterpillars into winged insects has long excited our admiration. But transformation is not confined to them: all animals, without exception, undergo changes in their structure, mode of existence, and external appearances. Mankind, from their embryo state to their final dissolution, assume many different forms. With respect to an infant, immediately after birth, it is observable to all, that its form, its symmetry, and its organs, are by no means complete. The head, for some time, is disproportionally large; the hands and feet are not properly shaped; the hair is short and scanty; and no teeth appear. In a few months, however the symmetry of all the parts is evidently improved, and the teeth begin to shoot. The growth of the whole body, and the strength and beauty of its form, gradually advance to perfection till the sixth or seventh year, when another change takes place. At this period, the first set of teeth are shed, and are replaced by new ones. From boyhood to puberty, the size of the body, and of its different members, increases. When the age of puberty arrives, several important changes are produced. From this period, to the age of twenty-five or thirty, the muscles swell, their interstices are filled with fat, the parts bear a proper proportion to each other, and man may now be considered as a perfect animal. In this state of perfection and vigour, he generally remains till he reaches his fiftieth year. Then a new, but a gradual change, begins to appear. From the fiftieth year to the age of seventy or eighty, the powers of the body decline in strength and activity. The muscles lose their spring and their force; the vigour of manhood is no longer felt; and the decrepitude of old age is succeeded by death, its unavoidable consequence.

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[1] For more on this subject, consult Lesser's Insecto-Theology, by *Lyonet*, 8vo. Lond. 1799, a highly curious and interesting work.

The mind of man undergoes changes as well as his body. The taste, appetites, and dispositions, are in perpetual fluctuation. How different is the taste of a child from that of a man! Fond of gewgaws and of trifling amusements, children frolic away their time without much reflection. When advancing toward puberty, their dispositions and desires suffer a gradual mutation. New instincts are unfolded, and a sense of propriety begins to be perceived. They despise their former occupations and amusements; and different species of objects solicit and obtain their attention. Their [illegible] of reflection are now considerably aug[illegible] and both sexes acquire a modesty and a [illegible] regard to each other. This awkward, [illegible] bashfulness, by the intercourse of society, as well as by the impulses of nature, vanishes soon after puberty, when the state of manhood commences. From this period, to the age of twenty-five or thirty, men's minds assume a bold, enterprising, and active tone. They engage in the business of life, look forward to futurity, and have a desire of marrying, and of establishing families. All the social appetites are in vigour; solid and manly friendships are formed; and man goes on for some time to enjoy every kind of happiness which his nature is capable of affording. At fifty or sixty, the mental powers, in general, like those of the body, begin to decline, till feeble old age arrives, and death terminates the scene.

With regard to quadrupeds, both before and after birth, they undergo similar, and many of them greater changes of form than those of the human species. Their mental powers, likewise, their dispositions and manners, as well as the objects of their attention, vary according to the different stages of their existence. Many of them come into the world blind, and continue for some time before they receive the sense of seeing. How many changes are exhibited in the dog from birth till he becomes a perfect animal, till all his members are completely formed, and all his instincts are unfolded and improved by experience and education! The deer-kind acquire not their magnificent and beautiful horns before the age of puberty; and even these are annually cast off and renewed. Similar changes take place in quadrupeds of every denomination.

Many birds, like quadrupeds, are blind for some time after they are hatched. In this condition, how different are their form and appearances from those of the perfect animals! At first, they are covered with a kind of down instead of feathers. Even after the feathers shoot, they are often of a colour different from that which they acquire when full grown. The beautiful variegated colours of the peacock's tail appear not till he arrives at his third year. Birds that have crests, live a considerable time before they acquire these ornaments. All birds annually moult, or cast their feathers, in the same manner as quadrupeds shed their hair.

Frogs, and many other amphibious animals, undergo great changes in their form and structure. When it first escapes from the egg, a frog appears in the form of a tadpole, an animal with a large roundish head, and a compressed or flat tail, but destitute of feet and legs. In this state it remains a considerable time, when the two fore-feet begin to shoot, and have an exact resemblance to the buds of trees. As their growth advances, the toes and legs are distinguishable. The same process goes on with the hind legs, but they are somewhat later in making their appearance. During the growth of the legs, the blood being drawn into different channels, the tail suffers a gradual mortification, till at last it vanishes, and the tadpole is metamorphosed into a quadruped. Tadpoles never come out of the water; but, after their transformation into frogs, they become amphibious, and occasionally frequent both land and water.

The crustaceous tribes, as lobsters, crabs, &c. beside the different appearances they assume while growing to perfection, cast their shells every year. When this change is about to happen, they retire into the crevices of rocks, or shelter themselves below detached stones, with a view to conceal and defend their bodies from the rapacious attacks of other fishes. After the shells are cast, the animals are exceedingly weak and defenceless. Instead of their natural defence of hard shells and strong claws, they are covered only with a thin membrane or skin. In this state they become an easy prey to almost every fish that swims. The skin, however, gradually thickens and grows harder till it acquires the usual degree of firmness. By this time the animals have resumed their former strength and activity; they come out from their retreats, and go in quest of food.

Serpents, and many other reptiles, cast their skins annually. The beauty and lustre of their colours are then highly augmented. Before casting, the old skins have a tarnished and withered appearance. The old skins, like the first set of teeth in children, are forced off by the growth of the new.

But transformations are not peculiar to animals. All organized bodies pass through successive changes. Plants, of course, are not exempted from mutation. What an amazing difference between an acorn and a stately oak! The seeds of plants may be compared to the chrysales of butterflies. The seed, like the chrysalis, contains, in miniature, all the parts of the future plant. These parts require only time, and other circumstances necessary to vegetation, for their complete evolution. How different are the seed-leaves from those of the plume! Beside the general changes arising from growth, plants undergo a number of metamorphoses from other causes. In northern climates, if we except a few evergreens, trees, during winter, are entirely stripped of their leaves. Instead of the pleasant emotions excited by the variety of figures, movements, colours, and fragrance of the leaves, flowers, and fruit, during the spring and summer, nothing is exhibited in winter but the bare stems and branches. In this state, the trees of the forest have a lugubrious appearance. Very different are the emotions we feel in spring, when the buds begin to burst, and the leaves to expand. When summer approaches, another beautiful change takes place. The flowers with all their splendour of colours, and sweetness of scents, are then highly delightful to our senses. After performing the office of cherishing and protecting the tender fruit for some time, the flowers drop off, and a new change is exhibited. When the flowers fall, the young fruit appear, and gradually grow to maturity, perpetually presenting varieties in their magnitude, colour, odour, and flavour. When the fruit and seed are fully ripe, they are gathered for the use of man, drop down upon the earth, or are devoured by birds and other animals. After this change happens, to which all the others were only preparatory, the leaves begin to shed, winter commences, and the same series of metamorphoses goes on during the existence of the plant.

The changes just now mentioned are annual, and are ultimately intended to supply men and other animals with food. But plants are subjected to changes of form from causes of a more accidental nature. Varieties or changes in the figure of plants are often produced by soil, by situation, by culture, and by climate.

Thus it appears, that, in both the animal and vegetable kingdoms, forms are perpetually changing. The mineral kingdom is not less subject to metamorphoses. But though forms continually change, the quantity of matter is invariable. The same substances pass successively into the three kingdoms, and constitute in their turn, a mineral, a plant, an insect, a reptile, a fish, a bird, a quadruped, a man. In these transformations, organized bodies are principal agents. They change or decompose every substance that either enters into them, or is exposed to the action of their powers. Some they assimilate, by the process of nutrition, into their own substance; others they evacuate in different forms; and these evacuations make ingredients in the compositions of other bodies, as those of insects, whose multiplication is prodigious, and affords a very great quantity of organized matter for the nourishment and support of almost every animated being. Thus, from the apparent vilest and most contemptible species of matter, the richest productions derive their origin. The most beautiful flowers, the most exquisite fruits, and the most useful grain, all proceed from the bosom of corruption. The earth is continually bestowing fresh gifts upon us; and her powers would soon be exhausted, if what she perpetually gives were not perpetually restored to her. It is a law of Nature, that all organized bodies should be decomposed, and gradually transformed into earth. While undergoing this species of dissolution, their more volatile particles pass into the air, and are diffused through the atmosphere. Thus animals, at least portions of them, are buried in the air, as well as in the earth, or in water. These floating particles soon enter into the composition of new organized beings, who are themselves destined to undergo the same revolutions. This circulation of organized matter has continued since the commencement of the world, and will proceed in the same course till its final destruction.

With regard to the intentions of Nature in changing forms, a complete investigation of them exceeds the powers of human research. One great intention, from the examples above enumerated, cannot escape observation. In the animal world, every successive change is a new approach to the perfection of the individuals. Men, and the larger animals, some time after the age of puberty, remain stationary, and continue to multiply their species for periods proportioned to their respective species. When these periods terminate, they gradually decay till their final dissolution. The same observation is applicable to the insect tribes, whose trans formations strike us with wonder. The caterpillar repeatedly moults, or casts its skin. The butterfly existed originally in the body of the caterpillar; but the organs of the fly were too soft, and not sufficiently unfolded. It remains unfit to encounter the open air, or to perform the functions of a perfect animal, till some time after its transformation into a chrysalis. It then bursts through its envelope, arrives at a state of perfection, multiplies its species, and dies. All the changes in the vegetable kingdom tend to the same point. In the process of growing, they are perpetually changing forms till they produce fruit, and then they decay. Some plants, like caterpillars, go through all their transformations, death not excepted, in one year. But others, like man and the larger animals, beside the common changes produced by growth and the evolution of different organs, continue for many years in a state of perfection before the periods of decay and of dissolution arrive. But these perennial plants undergo, every year, all the vicissitudes of the annuals. They every year increase in magnitude, send forth new leaves and branches, ripen and disseminate their seeds, and, during winter, remain in a torpid state, or suffer a temporary death.

With respect to man in particular, it might be inquired, why he is confined to so very short a period of existence here, whose intellectual attainments seem to be too vast, his ambition too exalted, to perish for ever? He undergoes a momentary change; he perishes for a season; to him, who improves his powers, and perseveres in the paths of piety and virtue, is promised another and more glorious transformation—a resurrection to immortal life and everlasting joy.

I shall conclude this Paper by observing, that to some of the preceding observations nothing can be ore applicable than the awful reflections of Dr. oung:

Lorenzo! such the glories of the world!
What is the world itself? *Thy* world—a grave.
Where is the dust that has not been alive?
The spade, the plough, disturb our ancestors;
From human mould we reap our daily bread.
The globe around earth's hollow surface shakes,
And is the ceiling of her sleeping sons.
O'er devastation we blind revels keep;
Whole buried towns support the dancer's heel.
The *moist* of human frame the sun exhales;
Winds scatter through the mighty void the *dry*;
Earth repossesses part of what she gave,
And the freed spirit mounts on wings of fire;
Each element partakes our scattered spoils;
As nature, wide, our ruins spread: man's death
Inhabits all things, but the thought of man.

No. XXXVII.

ON THE BEAUTY AND VARIETY OF BUTTERFLIES.

Behold! ye pilgrims of this earth, behold!
See all but man with unearned pleasure gay:
See her bright robes the butterfly unfold,
Broke from her wintry tomb in prime of May!
What youthful bride can equal her array?
Who can with her for easy pleasure vie?
From mead to mead with gentle wing to stray,
From flow'r to flow'r on balmy gales to fly,
Is all she has to do beneath the radiant sky.

THOMSON.

AMID the vast profusion of beautiful objects in he creation, no one seems more admirably formed o attract the attention of a Contemplative Philosopher, than the Papilio or Butterfly. The beauty of this insect, the splendour and astonishing variety of its colours, its elegant form, its sprightly air, with its roving and fluttering life, all unite to captivate the least observant eye. A collection of butterflies, such as that in the British Museum, or in Mr. Bullock's Museum, is a spectacle for the most philosophic mind. These insects, indeed, seem to vie with each other in beauty of tints and elegance of shape.

The butterflies of China, and particularly those of America, on the river Amazon, are remarkable for their size, and for the richness and vivid lustre of their colours. Nor is it too bold an assertion, perhaps, that the butterflies of these hot climates afford instances of the most perfect art of colouring that even Deity itself can produce. But no description can be adequate to that of which the sight alone can form a competent idea. Hence, in the oriental countries, where the butterfly is so much larger and more beautiful than ours, it is no wonder, that it forms a principal ornament of their poetry.

To this superiority, as well as to the evanescent and fragile splendour of the butterfly, Lord Byron alludes in the following exquisite simile:

As rising on its purple wing
The insect queen[1] of eastern spring,
O'er emerald meadows of Kashmeer
Invites the young pursuer near,
And leads him on from flow'r to flow'r,
A weary chase and wasted hour,
Then leaves him as it soars on high,
With panting heart and tearful eye:
So Beauty lures the full-grown child
With hue as bright, and wing as wild;
A chase of idle hopes and fears,
Begun in folly, closed in tears.

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[1] The blue-winged butterfly of Kashmeer, the most rare and beautiful of the species.

If won, to equal ills betrayed,
Woe waits the insect and the maid,
A life of pain, a loss of peace,
From infant's play and man's caprice:
The lovely toy, so fiercely sought,
Has lost its charm by being caught;
For every touch that wooed its stay
Has brushed its brightest hues away,
Till charm, and hue, and beauty gone,
'Tis left to fly or fall alone.
With wounded wing, or bleeding breast,
Ah! where shall either victim rest?
Can this with faded pinion soar
From rose to tulip as before?
Or Beauty, blighted in an hour,
Find joy within her broken bow'r?
No! gayer insects flutt'ring by
Ne'er droop the wing o'er those that die,
And lovelier things have mercy shown
To ev'ry failing but their own;
And ev'ry woe a tear can claim
Except an erring sister's shame.

Nature, in these insects, seems to have been fond to sport in the artificial mixture and display of her most radiant treasures. In some, what elaborate harmony of colouring, what brilliancy of tints, what soft and gradual transitions from one to another! In the wings of others we may observe the lustre and variety of all the colours of gold, and silver, and azure, and mother of pearl; the eyes that sparkle on the peacock's tail; the edges bordered with shining silks and furbelows, the blended dies of Hungary point, and the magnificence of the richest fringe. In China, the finest and most extraordinary of these insects are sent to court, and applied to the decorations of the emperor's palace.

But with whatever admiration we view this beautiful insect with the naked eye, how greatly is the admiration augmented, when we examine it through the microscope! Would an uninformed spectator ever imagine, that the wings of the butterfly are furnished with feathers! And yet this is the opinion of some celebrated naturalists. That beautiful dust, say they, with which the wings of the butterfly are covered, and to which they owe both their opacity and variegated colouring, is an innumerable cluster of extremely small feathers, which cannot be discovered but by the microscope. The structure and arrangement of these feathers are described to be as perfect in symmetry, as they are beautiful in colouring; the parts which form their centre, and which immediately touch the wing, to be the strongest; those, on the contrary, which form the exterior circumference, to be more delicate, and of an extraordinary fineness. All these feathers, moreover, are said to have a quill at their root; and it is added, that if we seize the wing too roughly, we destroy the most delicate part of the plumage; but that if we wipe off all that was supposed to be powder, nothing remains but a fine and transparent membrane, where we may easily discern the little cavities or sockets, in which the quill of each feather was fixed. This membrane, from the manner in which it is embroidered, is represented to be almost as easily distinguished from the rest of the wing, as fine lace from the cloth upon which it is stretched. It is likewise said to be more porous and more delicate; to have the appearance of having been wrought by a needle; and to be terminated on the outline by a fringe, the threads of which are infinitely fine, and succeed each other with the most perfect regularity. Other naturalists, on the contrary, maintain that this seeming powder is a profusion of variously-coloured scales; but formed, however, in such a manner, as easily to deceive the eye by the appearance of feathers. The upper and under parts of the wing are equally furnished with these, and there is no species of this insect, in every wing of which there are not several figures of these feathers or scales in several parts.

> In down of ev'ry variegated die
> Shines flutt'ring soft, the gaudy butterfly:
> That powder, which thy spoiling hand disdains,
> The form of quills and painted plumes contains;
> Not courts can more magnificence express
> In all their blaze of gems and pomp of dress.
>
> BROWNE [1].

How much inferior must be the most magnificent robes, wrought by mortal hands, compared to the beautiful dress, with which Nature has invested the butterfly. Our richest laces are but coarse cloth, and our finest threads but cord, compared to the delicate texture that covers the wings of this insect. Such is the extreme difference to be observed between the works of Nature and those of Art, when we contemplate them through a microscope, that, while the first are finished to our utmost ideas of perfection, the latter, and even the most admirable of their kind, seem to be clumsily performed. But as this wonderful difference has been noticed in a former Paper[2], I need not enlarge on the subject here.

What is most astonishing in these wonderful insects is, that yesterday perhaps, they were produced from an abject and contemptible worm. But now they bear aloft their painted glories,

> Of all the varied dies,
> Their beauty-beaming parent can disclose. THOMSON.

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[1] The powder or down on the wings of the *lepidoptera*, or scaly-winged insects, is now allowed to be composed of very minute *scales*, and not of *feathers*, which differ in size and form in the different species.

[2] See No. XXXI.

With what vigour do they sport in the solar ray, exult in existence, inhale the odoriferous breeze, and rove in fickle flight from flower to flower.

> Their wings (all glorious to behold)
> Bedropt with azure, jet, and gold,
> Wide they display: the spangled dew
> Reflects their eyes and various hue [*]. GAY.

How wonderful this transformation from that reptile state, when struggling in the dust, they were in perpetual danger of being crushed by every careless foot! And by what omnipotent hand were they enabled thus to rise from the ground? Who endued them with power to traverse the aërial plains? Who adorned them with the vivid beauties of their wings?—God, the beneficent Creator of the butterfly and of - - - - man: God, who, in this wonderful insect, has presented us with an image of that transformation which awaits our own perishable bodies!—Yes, the day will at last arrive, when quitting this earthly tabernacle, the good man shall no longer creep below. The day will come, when, '*this corruptible must put on incorruption, and this mortal must put on immortality.*' The good man then, made perfect and glorified, will soar beyond the stars, and enjoy unutterable bliss in scenes of everlasting day.

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[*] Some of the most splendid butterflies, in this country, are seen in the month of August. The *papilio machaon*, commonly known as the swallow-tailed butterfly, is of a beautiful yellow, with black spots or patches along the upper edge of the superior wings: all the wings are bordered with a deep edging of black, decorated by a double row of crescent-shaped spots, of which the upper row is blue, and the lower yellow. The under wings are tailed, and are marked at the inner angle or tip with a round red spot, bordered with blue and black. Three others are particularly worthy of notice: (1) The *peacock butterfly* (Papilio Io), of an orange brown colour, with black bars intersected by spaces of yellow; (2) the *admirable butterfly* (Papilio Atalanta), of the most intense velvet black colour, with a carmine-coloured bar across the upper wings, which are spotted towards the tips with white; and (3) the *papilio paphia*, an highly elegant insect of a fine orange chesnut colour above, with numerous black spots and bars. It is usually found in the neighbourhood of woods. To these may be added, the black-eyed marble butterfly (Papilio Semele), and the small golden black-spotted butterfly (Papilio Phlæas).

The following stanzas, attributed to one of the first scholars of the present day, are so strictly in unison with the sentiments of the Contemplative Philosopher, and possess so much poetical merit, that they will form no inappropriate conclusion to the present Paper.

BIRTH OF THE BUTTERFLY.

The shades of night were scarcely fled,
  The air was mild, the winds were still,
And slow the slanting sun-beams spread
  O'er wood and lawn, o'er heath and hill.

From fleecy clouds of pearly hue
  Had dropt a short but balmy show'r,
That hung like gems of morning dew,
  On ev'ry tree, on ev'ry flow'r.

And from the blackbird's mellow throat
  Was poured so long and loud a swell,
As echoed with responsive note,
  From mountain side and shadowy dell.

When, bursting forth to life and light,
  The offspring of enraptured *May*,
The Butterfly, on pinions bright,
  Launched in full splendour on the day.

Unconscious of a mother's care,
  No infant wretchedness it knew;
But, as she felt the vernal air,
  At once to full perfection grew.

Her slender form, etherial, light,
Her velvet-textured wings unfold,
With all the rainbow's colours bright,
And dropt with spots of burnished gold.

Trembling awhile, with joy she stood,
And felt the Sun's enliv'ning ray,
Drank from the skies the vital flood,
And wondered at her plumage gay;

And balanced oft her broidered wings,
Thro' fields of air prepared to sail;
Then on her vent'rous journey springs,
And floats along the rising gale.

Go, child of pleasure, range the fields—
Taste all the joys that Spring can give—
Partake what bounteous Summer yields,
And live, while yet 'tis thine to live.

Go, sip the rose's fragrant dew—
The lily's honied cup explore—
From flow'r to flow'r the search renew,
And rifle all the woodbine's store.

And let me trace thy vagrant flight,
Thy moments, too, of short repose;
And mark thee, when, with fresh delight,
Thy golden pinions ope and close.

But hark! while thus I musing stand,
Pours on the gale an airy note,
And, breathing from a viewless band,
Soft silvery tones around me float.

They cease—but still a voice I hear,
A whispered voice of hope and joy—
Thy hour of rest approaches near,
Prepare thee, mortal! thou must die!

Yet, start not, on thy closing eyes
Another day shall still unfold;
A sun of milder radiance rise,
A happier age of joys untold.

Shall the poor worm that shocks thy sight,
The humblest form in Nature's train,
Thus rise in new-born lustre bright,
And yet the emblem teach in vain?

Ah! where were once her golden eyes,
  Her glitt'ring wings of purple pride?
Concealed beneath a rude disguise!
  A shapeless mass to earth allied.

Like thee, the hapless reptile lived,
  Like thee she toiled, like thee she spun;
Like thine, her closing hour arrived,
  Her labour ceased, her web was done.

And shalt thou, numbered with the dead,
  No happier state of being know?
And shall no future morrow shed
  On thee a beam of brighter glow?

Is this the bound of Pow'r divine,
  To animate an insect frame?
Or shall not He who moulded thine
  Wake, at his will, the vital flame?

Go, mortal! in thy reptile state,
  Enough to know to thee is given;
Go, and the joyful truth relate,
  Frail child of Earth, high heir of Heav'n.

No. XXXVIII.

N THE WONDERFUL OPERATIONS OF BEES.

Ac veluti in pratis, ubi apes in æstate serena
Floribus insidunt variis, et candida circum
Lilia funduntur— VIRGIL.

To their delicious task the fervent bees,
In swarming millions tend: around, athwart,
Through the soft air, the busy nations fly,
Cling to the bud, and with inserted tube,
Suck its pure essence, its etherial soul;
And oft, with bolder wing, they soaring dare
The purple heath, or where the wild thyme grows,
And yellow load them with the luscious spoil.
THOMSON.

THE wisdom of the Bees, the perfection and rmony of their government, their persevering industry, and wonderful economy, have been celebrated by the natural historians of every age. Nor has this subject been forgotten by the poets. These industrious insects, have furnished them with similes from the remotest times. The great father of poetry compares a crowded host of Greeks to a swarm of bees [1]. The Tyrians, employed in building a city, are compared by Virgil, to bees performing their wonderful operations [2]. My motto, from the same author, is part of a simile, in which he compares the ghosts, flitting near the river Lethe, to bees roving in the meads from flower to flower [3]. But Milton has carried the similitude farther than any of his great masters; for he introduces the consultation of the fallen angels in Pandemonium, by a description of bees expatiating and conferring their state affairs [4]. Horace, in the fine ode, in which he styles Pindar the Theban Swan, modestly compares himself to a bee, roving with feeble wing and idle murmurs, and with unceasing labour, culling from each bloom his flowery spoils [5]. Lucretius too, while employed in collecting and elucidating the doctrines and lessons of his master Epicurus, compares himself to the bee, extracting honey from the most fragrant flowers [6]. Shakspeare exalts the subject to far greater consequence; for he describes the busy nation as a monarchy:

> So work the honey bees;
> Creatures, that by a rule in nature teach
> The art of order to a peopled kingdom.
> They have a king, and officers of sort;
> Where some, like magistrates, correct at home;
> Others, like merchants, venture trades abroad;
> Others, like soldiers, armed in their stings,

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[1] *Iliad*, ii. 87.

[2] Æneid, i. 430.

[3] Ib. vi. 707.

[4] *Paradise Lost*, i. 768.

[5] Lib. iv. Od. 2.

[6] Lib. iii. 2.

Make boot upon the summer's velvet buds,
Which pillage they with merry march bring home
To the tent royal of their emperor,
Who, busied in his majesty, surveys
The singing mason building roofs of gold;
The civil citizens kneading up the honey;
The poor mechanic porters crowding in
Their heavy burdens at his narrow gate;
The sad eyed justice, with his surly hum,
Delivering o'er to executors pale
The lazy yawning drone[1].

Pope also has the following lines:

Learn each small people's genius, policies,
The ant's republic, and the realm of bees;
How those in common all their wealth bestow,
And anarchy without confusion know;
And these for ever, though a monarch reign,
Their separate cells and properties maintain.
Mark what unvaried laws preserve each state,
Laws wise as Nature, and as fixt as Fate[2].

And Churchill, after the following beautiful and picturesque description, introduces a sovereign, drawing from it, in a soliloquy, the most natural reflections on the momentous duties of his station:

Strength in her limbs, and on her wing dispatch,
The bee goes forth; from herb to herb she flies,
From flow'r to flow'r, and loads her lab'ring thighs
With treasured sweets; robbing those flowers, which left
Find not themselves made poorer by the theft,
Their scents as lively, and their looks as fair,
As if the pillager had not been there.
Ne'er doth she flit on Pleasure's silken wing;
Ne'er doth she, loit'ring, let the bloom of Spring
Unrifled pass, and on the downy breast
Of some fair flow'r indulge untimely rest.
Ne'er doth she, drinking deep of those rich dews
Which Chymist Night prepared, that faith abuse
Due to the hive, and, selfish in her toils,
To her own private use convert the spoils.
Love of the stock first called her forth to roam,
And to the stock she brings her honey home[3].

[1] King Henry V. Act. i.

[2] *Essay on Man*, iii.

[3] Gotham, book iii.

This golden daughter of the Spring,
From mead to mead, in wanton labour roves,
And loads its little thigh, or gilds its wing
With all the essence of the flushing groves:
Extracts the aromatic soul of flowers,
And, humming in delight, its waxen bowers
Fills with the luscious spoils, and lives ambrosial hours.

But more quotations are superfluous: to the poetical part of my subject, therefore, I shall only add, what every classical reader will recollect, that Virgil has devoted the fourth book of his Georgics entirely to the subject of bees; a subject, which he paints *con amore*, 'in all the matchless harmony of song.'

The skill and dexterity of the honey-bees, displayed in the construction of their combs or nests, are truly wonderful. They are composed of cells regularly applied to each other's sides. These cells are uniform hexagons or six-sided figures. In a bee-hive, every part is arranged with such symmetry, and so finely finished, that, if limited to the same materials, the most expert workman would find himself unqualified to construct a similar habitation, or rather a similar city.

In the formation of their combs, bees seem to resolve a problem which would not be a little puzzling to some geometers; namely, a quantity of wax being given, to make of it equal and similar cells of a determined capacity, but of the largest size in proportion to the quantity of matter employed, and disposed in such a manner as to occupy in the hive the least possible space. Every part of this problem is completely executed by the bees. By applying hexagonal cells to each other's sides, no void spaces are left between them; and, though the same end might be accomplished by other figures, yet they would necessarily require a greater quantity of wax. Besides, hexagonal cells are better fitted to receive the cylindrical bodies of these insects. A comb consists of two rows of cells applied to each other's ends. This arrangement both saves room in the hive, and gives a double entry into the cells of which the comb is composed. As a further saving of wax, and preventing of void spaces, the bases of the cells in one row of a comb serve for bases to the opposite row. In a word, the more minutely the construction of these cells is examined, the more will the admiration of the observer be excited. The walls of the cells are so extremely thin, that their mouths would be in danger of suffering by the frequent entering and issuing of the bees. To prevent this disaster, they make a kind of ring round the margin of each cell, and this ring is three or four times thicker than the walls.

It is difficult to perceive, even with the assistance of glass-hives, the manner in which bees operate when constructing their cells. They are so eager to afford mutual assistance, and, for this purpose, so many of them crowd together, and are perpetually succeeding each other, that their individual operations can seldom be distinctly observed. It has however, been plainly discovered, that their two teeth are the only instruments they employ in modelling and polishing the wax. With a little patience and attention, we perceive cells just begun. We likewise remark the quickness with which a bee moves its teeth against a small portion of the cell. This portion the animal, by repeated strokes on each side, smooths, renders compact, and reduces to a proper thinness of consistence. While some of the hive are lengthening their hexagonal tubes, others are laying the foundations of new ones. When a bee puts its head a little way into a cell, we easily perceive it scraping the walls with the points of its teeth, in order to detach such useless and irregular fragments as may have been left in the work. Of these fragments the bee forms a ball about the size of a pin's head, comes out of the cell, and carries this wax to another part of the work where it is needed. It no sooner leaves the cell than it is succeeded by another bee, which performs the same office, and in this manner the work is successively carried on till the cell is completely polished.

The cells of bees are designed for different purposes. Some of them are employed for the accumulation and preservation of honey. In others, the female deposits her eggs. and from these eggs worms are hatched, which remain in the cells till their final transformation into flies. The drones or males are larger than the common or working bees: and the queen, or mother of the hive, is much larger than either. A cell destined for the lodgement of a male or female worm must, therefore, be considerably larger than the cell of the smaller working bees. The number of cells destined for the reception of the working bees far exceed those in which the males are lodged. The honey-cells are always made deeper and more capacious than the others. When the honey collected is so abundant that the vessels cannot contain it, the bees lengthen, and of course deepen the honey-cells.

Their mode of working, and the disposition and division of their labour, when put into an empty hive, do much honour to the sagacity of bees. They immediately begin to lay the foundations of their combs, which they execute with surprising quickness and alacrity. Soon after they begin to construct one comb, they divide it into two or three companies, each of which, in different parts of the hive, is occupied with the same operations. By this division of labour, a great number of bees have an opportunity of being employed at the same time, and, consequently, the common work is sooner finished. The combs are generally arranged in a direction parallel to each other. An interval, or street, between the combs, is always left, that the bees may have a free passage, and an easy communication with the different combs in the hive. These streets are wide enough to allow two bees to pass one another. Beside these parallel streets, to shorten their journey when working, they leave several round cross passages, which are always covered.

With respect to the materials employed by bees, it is known that they carry into their hives, by means of their hind thighs, great quantities of the farina or dust of flowers[1]. After many experiments made by Reaumur, with a view to discover whether this dust contained real wax, he was obliged to acknowledge, that he could never find the wax formed any part of its composition. He at length found, by attentive observation, that the bees actually eat the farina which they so industriously collect; and that this farina, by an animal process, is converted into wax. This digestive process, which is necessary to the formation of wax, is carried on in the second stomach, and perhaps in the intestines of bees. Reaumur likewise discovered, that all the cells in a hive were not destined for the reception of honey, and for depositing the eggs of the female, but that some of them were employed as receptacles for the farina of flowers, which is the great basis and raw material of all their curious operations. When a bee comes to the hive with its thighs filled with farina, it is often met near the entrance by some of its companions, who first take off the load, and then devour the provisions so kindly brought to them. But, when none of the bees employed in the hive are hungry for this species of food, the carriers of the farina deposit their loads in cells prepared for that purpose. To these cells the bees resort, when the weather is so bad that they cannot venture to go to the fields in quest of fresh provisions. As a further evidence that the bees actually eat the farina of flowers, when the stomach and intestines are laid open, they are often found to be filled with this dust, the grains of which, when examined by the microscope, have the exact figure, colour, and consistence of farina, taken from the antheræ of particular flowers. After the farina is digested, and converted into wax, the bees possess the power of bringing it from their stomachs to their mouths. The instrument they employ in furnishing materials for constructing their waxen cells is their tongue, which is situate below the two teeth or fangs. When at work, the tongue is in perpetual motion, and its motions are extremely rapid: sometimes it is more or less concave, and partly covered with a moist paste or wax. By the different movements of its tongue the bee continues to supply fresh wax to the teeth, which are employed in raising and fashioning the walls of its cell, till they have acquired a sufficient height. As soon as the moist paste or wax dries, which it does almost instantaneously, it then assumes all the appearances and qualities of common wax. There is a still stronger proof that wax is the result of an animal process, When bees are removed into a new hive, and closely confined from the morning to the evening, if the hive chance to please them, in the course of the day, several waxen cells will be formed, without the possibility of a single bee having had access to the fields. Besides, the rude materials, or farina, carried into the hive, are of various colours. The farina of some plants employed by the bees is whitish: in others it is of a fine yellow colour; in others it is almost entirely red; and in others it is green. The combs constructed with these differently coloured materials are, however, when newly made, of a pure white colour, which becomes more or less tarnished by age, the operation of the air, or by other accidental circumstances. To bleach wax, therefore, requires only the art of extracting such foreign bodies as may have insinuated themselves into its substance and changed its original colour.

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[1] Among the trees and other vegetables most frequently visited by these industrious insects, may be mentioned the apple, almond, balm, bugloss, blackberry, bell-flower, bindweed, spanish broom, sweet-briar, alder, buckthorn, buckwheat, buttercup, borage, box, cherry, white and red clover, chesnut, and horse-chesnut, currant, elm, elder, furze, gooseberry, hawthorn, laurel, lavender, lily, lucerne, lupine, melilot, mignionette, rosemary, lemon thyme, golden rod and *heath*. Indeed, it is remarkable that in the vicinity of large heaths more honey is produced than in other parts.

Bees, from the nature of their construction, require a warm habitation. They are likewise extremely solicitous to prevent insects of any kind from getting admittance into their hives. To accomplish both these purposes, when they take possession of a new hive, they carefully examine every part of it, and, if they discover any small holes or chinks, they immediately paste them firmly up with a resinous substance which differs considerably from wax. This substance was unknown to the ancients: Pliny mentions it under the name of *propolis,* or bee-glue. Bees use this glue to render their hives more close and perfect, in preference to wax, because the former is more durable, and more powerfully resists the vicissitudes of weather than the latter. This glue is not, like wax, procured by an animal process: the bees collect it from different trees, as poplars, birches, and willows. It is a complete production of Nature, and requires no addition or manufacture from the animals by which it is employed. After a bee has procured a quantity sufficient to fill the cavities in its two hind thighs, it repairs to the hive. Two of its companions instantly draw out the glue, and apply it to fill up such chinks, holes, or other deficiencies, as they find in their habitation. But this is not the only use to which bees apply the glue. They are extremely solicitous to remove such insects, or foreign bodies, as happen to get admission into the hive. When so light as not to exceed their powers, they first kill the insect with their stings, and then drag it out with their teeth. But it sometimes happens that a snail creeps into the hive. It is no sooner perceived than it is attacked on all sides and stung to death. The bees cannot carry out a a burden of such weight; and to prevent so large a body from diffusing a disagreeable odour through the hive, they immediately cover every part of it with glue, through which no effluvia can escape. When a snail with a shell gets entrance, to dispose of it gives much less trouble to the bees. As soon as this kind of snail receives the first wound from a sting, it naturally retires within its shell. In this case, the bees, instead of pasting it all over, are contented to glue all round the margin of the shell, which is sufficient to render the animal immoveably fixed.

But glue, and the materials for making wax, are not the only substances these industrious animals have to collect. Beside the whole winter, there are many days in summer in which the bees are prevented by the weather from going abroad in quest of provisions. They are, therefore, under the necessity of collecting, and amassing in cells destined for that purpose, large quantities of honey. This sweet and balsamic liquor they extract, by means of their proboscis or trunk, from the nectariferous glands of flowers. After collecting a few small rops of honey, the animal with its proboscis onveys them to its mouth and swallows them. From the gullet, it passes into the first stomach, which is more or less swelled in proportion to the uantity of honey it contains. When empty, it as the appearance of a fine white thread: but, when filled with honey, it assumes the figure of an oblong bladder, the membrane of which is so thin and transparent, that it allows the colour of the liquor it contains to be distinctly seen. The bees fly from one flower to another till they fill their first stomachs; then they return directly to the hive, and disgorge in a cell the whole honey they have collected. It not unfrequently happens, however, that a bee, when on its way to the hive, is accosted by a hungry companion. How the one can communicate its necessity to the other, is perhaps impossible to discover. But the fact is certain, that, when, two bees meet in this situation, they mutually stop, and the one whose stomach is full of honey extends its trunk, opens its mouth, and, like ruminating animals, forces up the honey into that cavity. The hungry bee knows how to take advantage of this hospitable invitation, and with the point of its trunk, sucks the honey from the other's mouth. When not stopped on the road, the bee proceeds to the hive, and in the same manner offers its honey to those who are at work, as if it meant to prevent the necessity of quitting their labour in order to go in quest of food. In bad weather, the bees feed upon the honey laid up in open cells; but they never touch these reservoirs when their companions are enabled to supply them with fresh honey from the fields. But the mouths of those cells which are destined for preserving honey during winter, they always cover with a lid or thin plate of wax.

The honey-bees not only labour in common with astonishing assiduity and art, but their whole attention and affections seem to centre in the person of the queen or sovereign of the hive. She is the basis of their association and of all their operations. When she dies by any accident the whole community are instantly in disorder. All their labours cease; no new cells are constructed; neither honey nor wax are collected. Nothing but perfect anarchy prevails, till a new queen or female is obtained. The government or society of bees is more of a monarchical than of a republican nature. All the members of the state seem to respect and to be directed by a single female. The fact affords a strong instance of the force and wisdom of Nature. The female alone is the mother of the whole hive, however numerous. Without her the species could not be continued. Nature, therefore, has endowed the rest of the hive with a wonderful affection to their common parent. For the reception of her eggs Nature impels them to construct cells, and to lay up stores of provisions for winter subsistence. These operations proceed from pure instinctive impulses. But every instinct necessarily supposes a degree of intellect, a principle to be acted upon, otherwise no impulse could be felt, and of course, no action nor mark of intelligence could possibly be produced.

Indeed, without some portion of mental sagacity, how should the different kinds of bees in the same hive be induced to perform so many different operations? While some are busily employed at home in the construction of cells, others are equally industrious in the fields collecting materials for carrying on the work. They are no sooner relieved from their load by their companions and fellow-labourers in the hive, than they again repair to the fields, and, with persevering industry, fly from flower to flower till they have amassed another load of materials, which

ey immediately transport to the hive. In this
borious office they persist for many hours every
ay, when the weather permits. Here every idea
f mechanical impulse is utterly excluded. That
ees, as well as other animals, are actuated by mo-
ves, or impulses, is willingly allowed. But these
re not mechanical impulses, as Buffon has absurdly
aintained: they are the wise and irresistible im-
ulses of Nature upon their minds. If bees did not
sociate, and mutually assist one another in their
arious operations, the species would soon be anni-
ilated. Not one of them, it is probable, would
rvive the first winter. But Nature, ever solicitous
r the preservation of her productions, has en-
owed their minds with an *associating principle*,
nd with instincts which stimulate them to per-
rm all those wonderful operations that are ne-
essary for the existence of individuals, and the
ontinuation of the species.

Mark how intensely, while the blazing day
Pours on their glowing *hives* its fiercest ray,
Yon *buzzing tribes* pursue their ceaseless toil,
Loaded with all the garden's fragrant spoil;
Dark'ning the air, behold th' unnumbered throng,
In driving swarms, harmonious glide along;
All in strong bonds of social union joined,
One mighty empire, one pervading mind:
No civil discords in that empire rage,
Save when on idle drones dire war they wage;
No tyrant's thundering scourge, nor rattling chain,
Disgrace the regent-mother's gentle reign;
Eternal laws to industry incite,
All, all, to swell the public stores unite.
Oh! would the MIGHTY STATES, *whose thunders hurled*
O'er ravaged EUROPE, *awe th' astonished world*,
Oh! would they imitate the blameless race,
Whose num'rous hives their names conspicuous grace[1]*?*

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[1] The apiary alluded to by the poet consisted of sixty-
ur hives, each of which was distinguished by the name
f some kingdom, or independent nation, beginning with

Their vig'rous industry, their loyal zeal,
Their gen'rous ardour for the public weal;
Be firmly bound by one grand social chain,
And bid through earth, ETERNAL CONCORD *reign!*
MAURICE.

Among late naturalists none has paid more successful attention to the habitudes and economy of bees than M. HUBER, who, under what would seem the greatest of all natural disadvantages, *blindness,* has penetrated into many of the secrets of nature in reference to these insects.

He presents us with a number of extraordinary facts relative to the *Queen-bee,* and among others, confirms the curious discovery of M. Shirach, that when bees are, by any accident, deprived of their queen, they have the power of selecting one or two grubs of workers, and converting *them* into queens; and that they accomplish this by greatly enlarging the cells of those selected larvas, by supplying them more copiously with food, and with food of a more pungent sort than is given to the common larvas.

On the subject of *swarms* M. Huber arrives at the following conclusions: 1st. A swarm is always led off by a single queen, either the sovereign of a parent hive, or one recently brought into existence. If, at the return of spring, we examine a hive well peopled, and governed by a fertile queen, we shall see her lay a prodigious number of male eggs in the course of May, and the workers will choose that moment for constructing several royal cells. 2dly. When the larvas hatched from the eggs laid by the queen in the royal cells are ready to transform to nymphs, this queen leaves

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the north of Europe, and including, in the same manner, Asia, Africa, and America; so that a kind of history of the world was exhibited in the habitations of the industrious bee.

the hive, conducting a swarm along with her; and the first swarm that proceeds from the hive is uniformly conducted by the old queen. 3dly. After the old queen has conducted the first swarm from the hive, the remaining bees take particular care of the royal cells, and prevent the young queens, successively hatched, from leaving them, unless at an interval of several days between each.

For more on this subject, the reader may consult M. Huber's valuable work—*Nouvelles Observations sur les Abeilles,* 2 tom. 8vo. Paris, 1814, including a new volume of very curious observations on this interesting insect. An able analysis of this work will be found in the *Edinburgh Review,* vol. xx. p. 319, and in vol. xxv. p. 363. See also Mr. John Hunter's Elaborate Account of Bees in the *Philosophical Transactions* for 1792, or *Dr. Shaw's General Zoology,* vol. vi. part ii. p. 289, and *Mr. Huish's* Treatise on Bees lately published.

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